New York State Museum Handbook 5

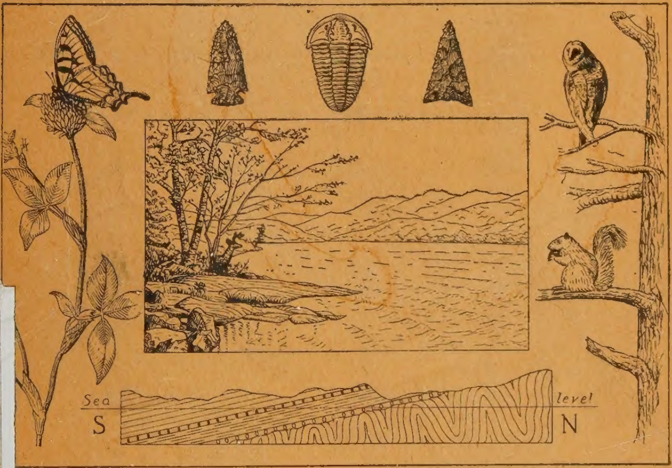
NEW YORK STATE MUSEUM

CHARLES C. ADAMS, *Director*

THE VEGETATION OF THE ALLEGANY STATE PARK

BY NORMAN TAYLOR

Curator, Brooklyn Botanic Garden



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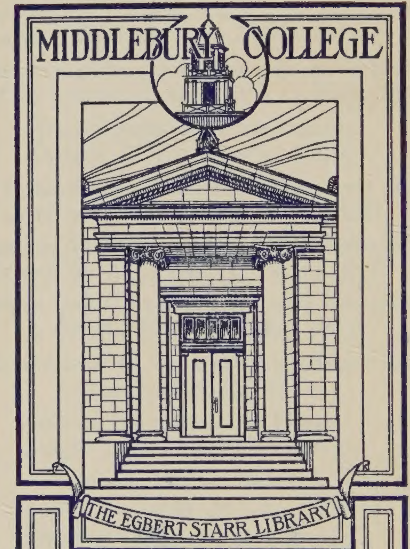

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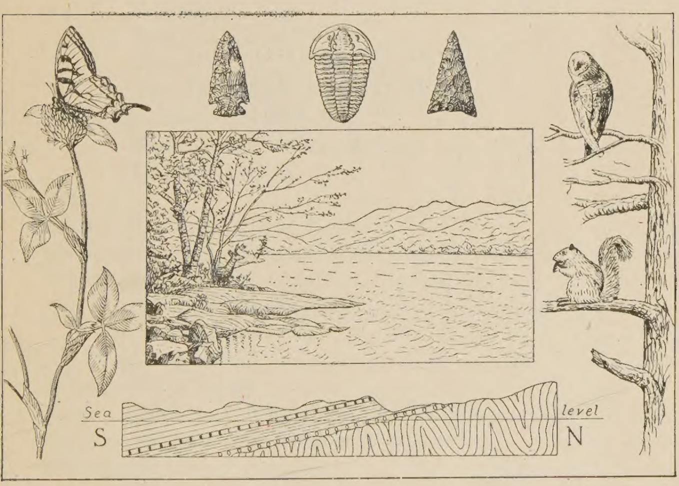

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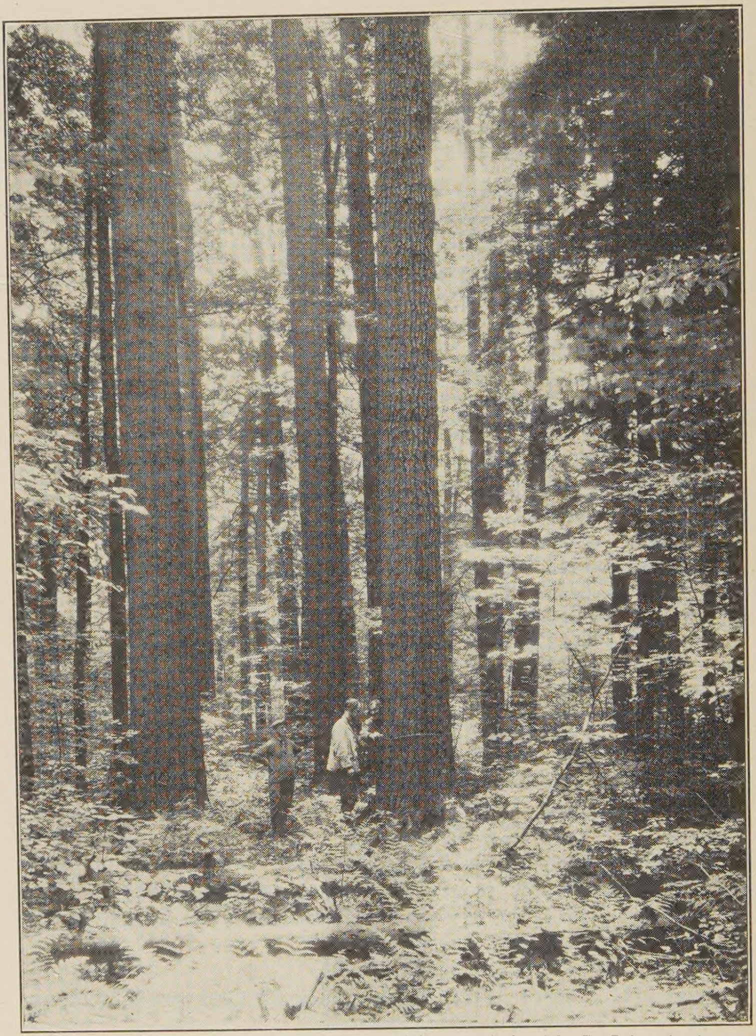

Photograph by M. G. Schneckenburger

Figure 1 Virgin White Pine, *Pinus strobus.* Trees up to five feet in diameter once grew in Allegany State Park. Only a few scattered and much smaller specimens are found there today. These from the Allegheny National Forest, Heart's Content, Pa.

New York State Museum

THE VEGETATION OF THE ALLEGANY STATE PARK*

By Norman Taylor

Curator, Brooklyn Botanic Garden

INTRODUCTION

Allegany State Park is a monument to the foresight of those who created it and evidence of the bounty of nature. Early in its history the area was stripped of all but a fraction of its magnificent forests. Fire then swept over much of the cut over land, and it took courage and vision to set aside such a large tract of second and third growth timber as a State Park. That foresight has been amply repaid by nature, which has decreed that the recovery from cutting and fire is very rapid. Nowhere except in a tropical rain-forest has the writer seen such speedy and complete recovery as in this Park.

Discussion of rainfall, temperature, soils, competition and a dozen other things that affect the distribution of vegetation—all these are interesting enough. But no one of them explains it all, and the casual visitor is obviously more struck by the results than by the cause of them. Everywhere one sees a luxuriant growth of trees, some very young, some nearly mature, and others which have already passed every stage of timber usefulness and now lie rotting in the forest. As dead waste? By no means. We shall see a little later how giant trees produce timber or else the incomparably more important function of producing conditions that make future timber possible (figure 19). See also page 89.

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* Issued also as Contributions from the Brooklyn Botanic Garden No. 54.

All thoughtful visitors must feel that the State has chosen well when it put this great wooded tract forever out of reach of the despoilers of nature's beauty. Now that cutting and all but accidental fires are stopped, the recovery and final development of the vegetation will reach its climax. For vegetation has a very definite development and does reach a climax, and this without much reference to the maturity and size of the individual trees in it. It is the story of that development and of the completely dramatic nature of that climax which makes up most of this little handbook.

As one drives through the park it is easy to infer that trees are just trees, that they are scattered rather thickly through the forest and that woods are confusing places where order or system is quite out of the question. Nothing is further from the truth. Forests and the plants that grow under them, and in fact all plants, are grouped in certain rather definite ways, and this again quite independently of the constituent members of the plant society as a whole. Nor is the use of "society" dragging that word from its usual mental niche and putting it in a foreign one. Plant societies have been recognized nearly as long as human societies, and many things that affect the one affect the other—heat, light and water, for instance. No one needs to be reminded that the Eskimo and Philippino are examples of such response as are the candle-lighted peasant and the city dweller. And who does not know the difference between the lean, parched Arab and a man from the moist climate of England? It is a truism that many things beside heat, light and water affect the distribution of human societies, but like many truisms it is not quite true. For human societies *in the end* are scattered over the world in the way they are, not in spite of these requirements but because of them. Dozens of other influences tug at these fundamentals, upset them for a time, but nature has her way in the end. Cases of arrested development or of long delayed destiny are too common to need reciting here. The world is strewn with human societies that are headed in the wrong direction or headed nowhere at all. But one thing no human society escapes is that the fundamental requirements of heat, light and water are properly taken care of. The disastrous floods on the Mississippi are a case in point and a famine in India is another.

If human societies respond to these fundamentals, in spite of all our modern complex life, how much more certain is it that plant societies are tenfold more sensitive to these requirements. While they lack our means to combat an unfavorable environment—steam, electricity, transportation and all the modern box of tricks—they are by no means at the mercy of it. Their adaptability is great, food and water requirements are seasonal, and every observant farmer knows how they seem to rush into flower and fruit in the face of moderately or unexpectedly unfavorable conditions.

There is a rather new term, "ecology," for this very old way of looking at plants and animals.

So old and tried is the way that Theophrastus (B.C. 370–286), who founded the first botanic garden, devotes more than eight chapters of perhaps the earliest of all botanical books to ecology. Of water plants, desert plants, alpine plants and coniferous forests he knew a lot. No modern student of ecology can ever forget the writings of this learned old Greek, nor our debt to the late E. L. Greene for reprinting pages of the writings of this "father of botany."

Farmers and gardeners have always been *ecologists,* without ever troubling themselves about the term. Within the past fifty years there has arisen a great mass of workers and data in *ecology* (Greek *οικος* house, λόγος, theory). It is literally the study of the house economy of plants and animals. How they grow, and why, if that is possible to tell. Most of this little handbook is an *ecological* account of the vegetation of the park.

Plant societies are just as real as human societies. There are several of them in the park. Some agree with their neighbors rather well on the whole. Among others there is a bitter struggle. The nature of the agreement and the bitterness of the struggle are not always apparent, and, just as in human society, it is much easier to note the result than to catch the causes in operation. But if we are to talk about plant societies in the park, come to know them, try to read their destiny, and think of them in terms of rather close corporations—and some of them are literally and exactly that—then we had better get to know them in the only way that civilized society recognizes—by an intelligent understanding of their individual identity, and their collective behavior.

The scientific names throughout this publication are those used by House and Alexander ('27).

PLANT SOCIETIES

In New York State Museum Handbook 2 House and Alexander have written an invaluable Flora of the Allegany State Park Region. They list all the wild plants of the park, tell where they can be found and plan out a series of excursions to find them. Visitors may perhaps wonder why another handbook about the plants of the Park is here offered. The answer to that is the heading of this section, for the *flora* of a region is a very different thing from the *plant societies* of the identical area. A *flora* enumerates all the individual *species* of plants. It concerns itself with their identity, often describes them, arranges them in some systematic grouping, as in families and genera; it is, in short, an enumeration of the individual constituents of the plant life of a region.

But an account of plant societies shoots at a different target. It is that phase of plant *ecology* which concerns itself with the local distribution of plants. Here we see the final reflection or register of not one but all the kaleidoscopic evidences of plant response and activities and history, working in harmony, or sometimes in violent conflict, and leaving as the result the wonderfully varied vegetation that covers the park today. If we could rightly interpret the story of which the vegetation is the silent narrator, it would tell us not only what happened in the past but what is likely to happen in the future.

Plant societies are very definite and real things, and perhaps the easiest way to recognize one is to pick out some typical example, look over its different aspects and get some idea of what it is all about.

THE FOREST SOCIETIES OF THE PARK

The Beech-Birch-Maple Forest

Plant societies, very much like human ones, are partly gregarious and quite often very exclusive. The herding tendency is often the best method of making exclusiveness effective and perhaps the best example of this is the main plant society in the park. Everywhere, except in a few cases to be noted later, the upland parts of the area are covered by a dense forest growth of the "Beech-Birch-Maple" forest type. It has been called this twice-hyphenated name because its principal trees are the common American Beech, *Fagus grandifolia,* the Yellow Birch, *Betula lutea,* and the Sugar Maple, *Acer saccharum.* There are, of course. other trees scattered among these dominant ones, but they need not be noted just yet, for we are most interested at the moment in getting an idea of how this main plant society of the park lives, keeps its place in the sun, fights off intruders and generally finds a method of perpetuating itself. For, again like human societies, a plant society to be permanently effective must be self-perpetuating.

Assuming that we are in the "Big Basin," where this type of forest is in its finest development, what is its chief characteristic? As one walks through its cathedral-like stillness under the vast canopy through which dimly filtered light discloses great stark boles rising clear of branches far up to the top, what strikes one? It is shade, of course, and tied up with shade and sunshine is nearly the whole story of the Beech-Birch-Maple forest and many other fascinating aspects of plant life in the Park.

Plants fight for light, as men will for food. Once having captured it they hold on indefinitely, if fire or cutting or some catastrophe does not interrupt. Exactly this is happening all over the park, but in the Big Basin the process is perhaps the most impressive, for here it has been least disturbed and is in the greatest perfection. The fight for light is relentless, for thousands of trees, even of the Beech and Birch and Maple are lost, that the survivors may live. One must view the present forest in the Big Basin as the remnants of a long continued and gigantic struggle.

Sunshine and shade. These were mentioned above as the things that dictated the occurrence of the Beech-Birch-Maple forest in the park. That is true, but again only a half truth, for it is the response of these three trees to light and shade that really matters. And all of these are tremendously *shade enduring.* That means that however dense a shade their lofty canopy may cast—and all over the Park we can see the almost cavernous quality of that shade—their own seedlings and young saplings will germinate and grow. It is no accident that under the Beech-Birch-Maple forest one rarely finds the seedlings of other trees and few herbs or shrubs (figure 2). The completeness of the canopy, casting its dense shade on the forest floor is here working for an exclusiveness more rigorous than a committee of some select club, for the latter occasionally lets in some outsider, which as we shall see later, the forest never does permanently. Upstarts and temporarily numerous species crowd into the quiet stillness of this forest but all will go the way of upstarts in the end, for all of them succumb to the relentless pressure of the Beech-Birch-Maple to maintain its own purity of composition. Some of the details of this struggle and several instances of it in various stages will be treated a little later. Before that we must stop a moment to look over the three trees that dominate this plant society, and some of their more common associates.

Beech. *Fagus grandifolia.* This is the most striking of the trio for its smooth, light gray bark, which is nearly the same in color and texture both in youth and advanced age, stands out against the darker colored hides of the Maple and Birch. It likes fairly rich soils, good drain-

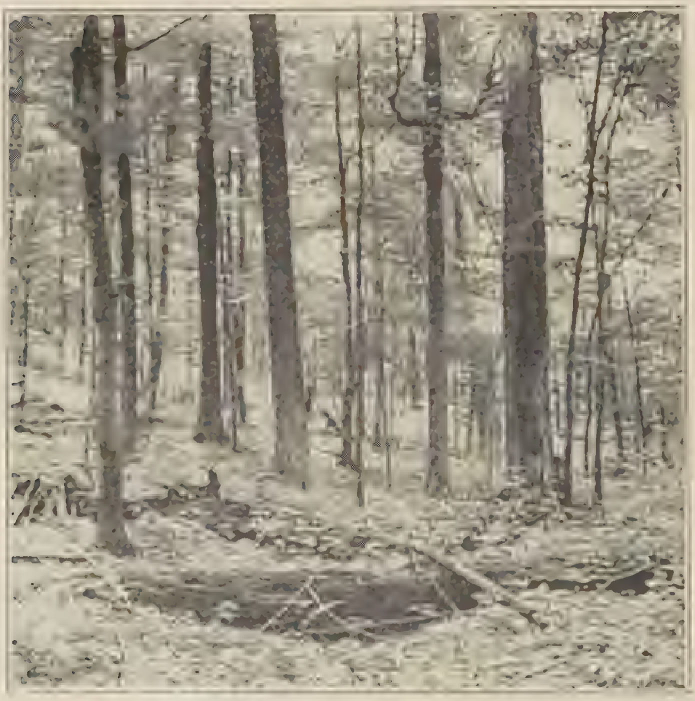


Figure 2 The forest floor under a mature canopy of the Beech-Birch-Maple in the Big Basin. Note the absence of much undergrowth, and see figure 9 for the contrast in the Oak-Hickory forests.

age, and, of all the trees in the park, is the most sensitive to cold. Many of its paper-thin leaves were, for instance, nipped by an unseasonably late frost in the latter part of June 1927, so that by the Fourth of July they looked blasted. About 80 years ago local legend has it that a similar late frost killed off many young Beech trees. We may thus think of it as not fully able to stand the rigors of the Allegany climate, but still sufficiently hardy to mature. Its almost paper-thin leaves, golden green when young but thicker and darker green in age, are less able to stand late frosts than are the leaves of some of the other trees.

The natural range of the Beech is from Nova Scotia and Ontario, west to Minnesota and Missouri and south to Florida and Texas. It has no other relative in America but has a line of ancestry stretching back to past geologic ages when beeches were of many kinds. All but four have passed away, the survivors being our own, the European relative, famous in song and story, and two other species in eastern Asia. Its tendency to exclusiveness is thus not surprising, but its real exclusiveness today does not come from antiquity but from another and much more effective cause. Perhaps as much as any of the trio it survives the densest shade. One finds its seedlings and young saplings enduring a shade that only its immediate associates in the Beech-Birch-Maple forest can tolerate. For years it will endure this, until ultimately its mature bole reaches up into the sunlit canopy, spreads out its crown, and casts a shade dense enough to keep out intruders.

Unhappily for the park, Beech has many uses and was much cut in the past, so that nearly mature beeches are to be found only in the Big Basin, at the extreme headwaters of Red House brook and at a few other localities. Its most dangerous recent foe is the fact that it is one of the important components of the so-called chemical forests whose wood is used for the manufacture of wood alcohol and other distillation products. An abandoned factory of this enterprise is still left in Red House valley, and in adjacent Pennsylvania the work goes on as an important industry. The creation of the park has stopped this menace to the Beech and its associates.

Yellow Birch, *Betula lutea.* There are only two species of Birch in the Park, and in maturity they are easily distinguished from each other. The Yellow Birch takes its name from the yellowish bark, but its most striking characteristic is the peeling off, in shaving like bits, of its papery outer bark. Young trees scarcely show this but older ones always do, and this is the most certain way of telling it from the Black Birch. The latter is also very common in the park. It derives its common name from its dark, blackish-red bark. The foliage of both these birches is very similar, and the only sure way to distinguish between them is from their very different bark.

Yellow Birch may be found in all stages of growth, and while still fairly young (under 40 feet in height) it is a numerous component of the Beech-Birch-Maple forest. It is not quite so tolerant of shade as the other two trees, and this is undoubtedly one of the chief reasons why in mature examples of the type, as in the Big Basin, its frequency is reduced and the Maple and Beech assume the preponderance. Both the Birches in the park have a rich wintergreen flavor in the bark of the young twigs, and one of the curious facts about the forest in this area is that it wholly lacks the birches which are without this flavor, the gray and canoe birches. The latter are so common in most parts of New York State that their failure to occur in the Park is one of the more interesting problems of plant distribution here.

Yellow Birch, like the Beech, is one of our most valuable hardwoods and has been much cut in the past for a variety of purposes. It is perfectly at home in the forest, especially in the younger stages, and you will find it throughout the park, with some few exceptions.

Sugar Maple, *Acer saccharum.* Of the six kinds of maples known from the park, this is the most frequent. It is, in fact, the commonest and most ubiquitous tree of the region. In all stages of the development of the Beech-Birch-Maple forest it is easily dominant and, as we shall see later, its percentage of frequency is very high. Even in forest types wholly different from the Beech-Birch-Maple—and some others are found in the park—the Sugar Maple is there.

As the source of maple sugar and extremely valuable timber—curly maple comes from it—this tree has been harvested for generations throughout the hardwood forest region of eastern America. Naturally it did not escape in the early cutting of what is now park land, so that only in a few places has it reached maturity, notably in the Big Basin. Here, at the extreme headwaters of Red House brook and at a few other localities it is to be found nearly at maturity, the great shaggy-barked boles rising for nearly a hundred feet without a branch and scarcely resembling youthful close-barked examples of it that are everywhere.

In its younger stages, before the mature rough bark shows itself, the tree resembles very closely the common Norway Maple of our streets and the parks. So close is the resemblance that these two trees are difficult to separate. One constant difference is that the leaf stalks of the Norway have a slightly milky juice while those of the Sugar Maple never do.

More than any other tree in the park the Sugar Maple endures shade, either its own or even the dense shade of the hemlocks. It will germinate and thrive under almost any conditions found in the park, which, of course, explains its commonness.

The trio of dominants. These three trees make up 80 per cent of the mature forest at Allegany State Park. All are shade-enduring beyond any others there, all prefer rich slopes, good soils, plenty of moisture, and above all, they contribute their bit to maintaining the purity of the forest type of which they are the chief components.

All over the world forests of this type have certain definite characteristics, and the Beech-Birch-Maple runs true to type. Like foreign representatives of this type, in eastern Asia for instance, there is the same tendency to maintain a dense, closed canopy, to cast an even denser shade, for the seedlings and young trees to be tolerant of that shade and to mature in spite of it, and finally and most important of all, to create conditions of humus, moisture and shade on its own forest floor that effectually keep out intruders.

Another very noticeable feature of such forests is that they develop bark characters and leaf characters peculiarly adapted to such conditions. At Allegany these three dominant trees all have thin bark and especially thin leaves. Contrast this with the coarse bark on an Oak tree and the leathery leaves of most Oaks, and it is at once evident that coolness, shade and moisture are things which the Beech-Birch-Maple appears rightly to take for granted. For none of these trees is provided with the thick bark or wind-resistant leaves of the Oaks and Hickories.

Moreover, this type of forest also provides a very different forest floor from more open woods. Under the Beech-Birch-Maple the humus is thick, rich, not too acid, and in it grow a variety of wild flowers at home nowhere else. But this is another story to be considered presently.

While this forest may seem to the casual visitor a rather mixed up assemblage of trees, actually the percentage of these three dominants is rather more steady on similar sites than one would suppose. As the result of many different counts of their frequency over widely scattered parts of the park, the following table shows the relative frequency of this trio of dominants:

Per cent of canopy trees of the dominant species in the Beech-Birch-Maple forest of Allegany State Park

	SUGAR MAPLE	YELLOW BIRCH	BEECH
Mature or nearly mature stands, as in the Big Basin or headwaters of Red House brook	40%	8%	36%
Younger stands, found all over the park	37%	15%	13%

These figures show plainly enough that Yellow Birch loses its frequency as the forest matures and that the frequency of the Beech increases with age. What the figures do not show is the time when competition for light and food begins to work those changes of which these figures are the final expression. And it can not have escaped the thoughtful reader that the sum of any of these percentages does not equal 100, and that there must be other trees in the forest. There are, and some of them must be noted before we go on to an entirely different forest type

Some associates of the trio. A number of trees of rather special interest are scattered through the Beech-Birch-Maple forest and should be known by sight at least, if one is to understand what follows. None of these secondary trees are found in any such numbers as the dominant trees but they *are* found with them nearly everywhere in the park. Most of those to be noted here appear to prefer conditions of shade and moisture which are created by the dominant species, and some of these less common species are found even in very old stands of the Beech-Birch-Maple. Only seven call for special mention here.

Hemlock. *Tsuga canadensis.* This, the most shade-enduring tree in the park, occurs everywhere. Formerly it was to be found in huge size and much more plentiful numbers than it is today. Years ago Hemlock was cut for its decidedly acid bark, which was used in tanning. Often in the old extravagant days merely the bark was sought, and all over the park one may find tremendous old Hemlock logs rotting on the ground. Now lumber is so much more valuable that even Hemlock, a decidedly inferior sort of timber, is saved. An example of this newer thrift are the buildings of the Allegany School of Natural History, largely built of Hemlock. The hillside at the back of the School was said to be nearly pure Hemlock 50 years ago, but today it is a nearly pure example of the Beech-Birch-Maple forest. This cutting of Hemlock went on almost throughout the park, so that today it is found everywhere, but almost never in pure stands of any extent. Scattered trees are everywhere; sometimes there may be small groves of it, but the writer has not found as much as an acre of pure Hemlock.

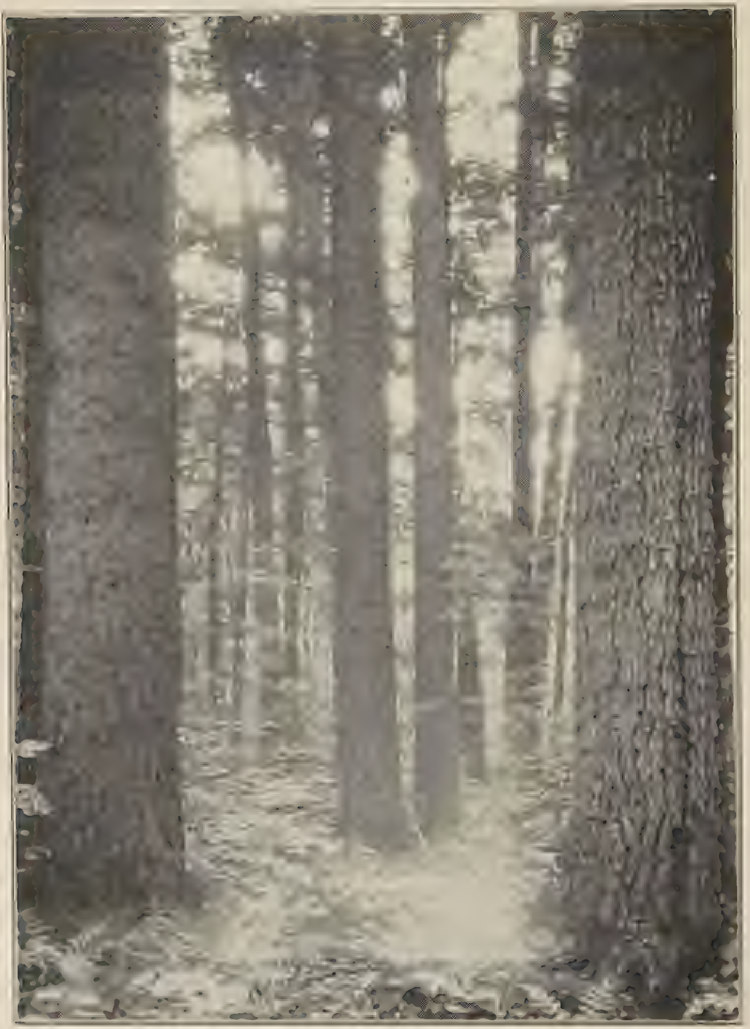
Where it does grow pure or nearly pure it tends to keep out nearly all other trees, partly because of the dense shade, partly because the heavy evergreen crown intercepts a great deal of rainfall, and partly also, because the duff or humus under Hemlock trees is extremely acid. See page 87. Beech, less so the Birch and Sugar Maple, are just able to stand the forest floor conditions under the Hemlock, but they do not like it.

The Hemlock does not like dry, open, windy places and you will find it usually in moist, protected places, and of course it is perfectly at home in the Beech-Birch-Maple forest. In various parts of the park Hemlock occurs in the Beech-Birch-Maple forest in the following percentages:

In mature or nearly mature stands................	6%
In medium and young stands......................	8%

These figures, however, mean less than percentages given for other trees, as the Hemlock was so thoroughly cut off in the tanbark days that its present percentages are certainly not what the original forest contained. It appears to be on the increase on moist, favorable sites, and years hence there should be a greater percentage of individuals and considerably larger groves than are found at present. The reason is that it is even more exclusive than the Beech, Birch or Maple, extraordinarily tolerant of its own shade and apparently indifferent to the shade of other trees. These factors and its acid humus appear to present barriers against intruders.

White Pine, *Pinus strobus.* Because this is the most valuable coniferous tree of eastern America, we never shall know its frequency in the old forest of Allegany State Park. Reliable reports tell us that all the virgin



Photograph by M. G. Schneckenburger

Figure 3 Virgin White Pine, *Pinus strobus*. Trees majestic as this once towered over the canopy of the hardwood forest in Allegany State Park. These are now growing in the Allegheny National Forest, Heart's Content, Pa. Average height about 175 feet; girth about 11½–12½ feet; age about 400 years.

stand was cut out years ago, as lumber companies cut White Pine and Hemlock before they began on the hardwoods. Today there are only a few young trees and no mature ones in the park. Even the white pines in a clump near the corner of the main road at its intersection with the Holt's Run road are nowhere near mature. This evergreen, the most stately and beautiful pine of the eastern United States, towers above all other trees in our flora. At Heart's Content, Pa., some fifty miles from the park, there is a mature grove of White Pine, whose majestic boles tower far above the undercanopy of deciduous trees (figure 1). Just this condition existed in the park before the cutting of White Pine. Exactly how many pines occurred to the acre no one knows, but it seems safe to say that in the Allegany Park, as in Pennsylvania, the tree grew as an occasional giant in the forest and when it was cut it failed to renew itself, because White Pine is intolerant of the shade of other trees. It is entirely unable to germinate on the normal forest floor of the Beech-Birch-Maple and, of course, is equally impotent to encroach under the Hemlock. So it is not surprising that the dominance of the Beech-Birch-Maple in the park restricts the occurrence of White Pine today to other parts of the area. Exactly this is happening as the sequel will show. There is, of course, the interesting question of how White Pine ever got a start in the Beech-Birch-Maple. The reasonable and probable explanation is that when a storm or old age or disease brought down some giant hardwood, or wherever for any reason a forest gap was made in the Beech-Birch-Maple canopy, White Pine seeded into such places, with some hope of success. Millions of White Pine seeds must have been sown in the park, but, barring some fortuitous circumstance which permitted their germination, they might as well never have been sent on a useless errand. This appears to be the reason why White Pine occurs so rarely in the Beech-Birch-Maple forest today and why it is restricted, generally speaking, to other parts of the park. More than almost any other tree at Allegany, it suffers from the exclusiveness of its neighbors.

Red Maple, *Acer rubrum.* This, the most gorgeously colored of all our native trees in autumn, is found everywhere in the park. Somewhat tolerant of shade and rather indifferent as to site, although it seems most at home in moist places, it succeeds in being a fair percentage of all forest types in the park, except the old, dense, and thoroughly mature Beech-Birch-Maple. It is no match for its relative, the Sugar Maple, in capturing cool, shaded forest floors, but it does form a considerable percentage of nearly all the other pieces of forest in the park. What an important part it plays in the development of the vegetation we shall see presently. It, more than almost any other tree in the park, serves its uses, points the way to a destiny in which it will have little or no part and then steps aside for more permanent trees.

Black Birch, *Betula lenta.* Like its more important relative, the Yellow Birch, Black Birch is found everywhere in the Beech-Birch-Maple forest, except in old mature stands. Its frequency of occurrence varies greatly, and in young woods and along the edges of clearings it is rather common. Almost never is it found in the Big Basin woods, as it appears not to be as long lived as the Yellow Birch, and shows a characteristic of many other species of trees in being more tolerant of shade when young than it is when it reaches maturity. That explains its gradual disappearance as the Beech-Birch-Maple reaches its final stages of development.

Wild Black Cherry, *Prunus serotina.* Unlike its favorite habit of growing along fence rows and other open places, which is such a common characteristic of this tree in most parts of the State, Wild Black Cherry is a real, though small component of the Beech-Birch-Maple forest in all stages of that forest's development. In young stands the Wild Black Cherry is frequent, in older ones less so, but even in the Big Basin it makes up an appreciable part, say 1 or 2 per cent of the mature canopy. It may well have been more than this in the old days, as its wood is valuable and it was cut for furniture.

White Ash, *Fraxinus americana.* Since no other canopy tree of the Beech-Birch-Maple has compound leaves, Ash is easily distinguished from any of its immediate neighbors. It grows in rich, not very moist sites and is found in most forest types in the park. Nowhere does it make up more than 2 per cent of the canopy, and in the Big Basin it is mostly less than this.

Cucumber Tree, *Magnolia acuminata.* With the largest leaves of any tree in the dominant forest type, the Cucumber Tree is a very striking if numerically unimportant member of the forests in the park. Descended from perhaps the most ancient of those trees with a geologically remote past, *Magnolia* is one of the most interesting trees in the region. Nowhere common, it is found as scattered individuals in nearly every piece of forest examined. Even in the gloomy deep recesses of the Big Basin there are occasional specimens and elsewhere it is more common. Like many of these secondary trees in the Beech-Birch-Maple, it is of more interest from the point of view of its distribution elsewhere and its extremely ancient ancestors than as any real component of the forest type, of which it appears as a more or less fortuitous member. It grows naturally from the Gulf states to New York and southern Ontario and is thus much nearer the northern edge of its range in Allegany than many other trees in the park. It is, nevertheless, hardy, it tolerates considerable shade and in young stands it is not uncommon.

As an illustration of how these secondary trees are scattered through a mature Beech-Birch-Maple forest at Allegany the following tally of a section of the Big Basin is given:

Sugar Maple	40%
Beech	36%
Yellow Birch	8%
Hemlock	6%
Wild Black Cherry	2%
White Ash	2%
Red Maple	2%
Cucumber Tree	1%
Other scattered species	3%
	100%

In no forest, of course, is there mathematical certainty in such percentages, but these represent many counts over many acres and the above is essentially the conditions to be observed in the mature forest. In a single acre of such there may be only about 150 trees, while a tally of a vigorous young stand near the summit of Lookout Trail has about 1200 trees to the acre. There could be no better example of what the competition for light does to the forest.

Shrubs and wild flowers. Under this deep, almost gloomy forest canopy there are comparatively few kinds of shrubs and wild flowers that can grow, for these smaller denizens of the Beech-Birch-Maple wage just as relentless a warfare for light and food as their taller associates. In the very heaviest forests of this type at Allegany, notably in the Big Basin, there are many square rods with absolutely no under-vegetation at all. This is particularly true under Hemlocks, but even without the severe conditions which that evergreen forces all herbs to overcome, there are still many places in the hardwood forest where lack of sunlight and interception of much rainfall by the forest canopy, and perhaps soil and humus conditions to be discussed later, all operate to keep shrubs and herbs down to a minimum (figure 2).

The wealth and luxuriance of wild flowers in the park, especially as one sees it from the roadsides, scarcely prepares one for the dearth of them in the interior of the forest. It is, of course, to the light along the roads, along stream sides and in clearings in the forest, that the great profusion of shrubs and wild flowers is due. Merely to go into the forest a hundred yards is to pass into a different floral world. Then for the first time one can understand the words of those early explorers of America, who wrote of riding horseback through our primitive forests, without let or hindrance, without trails and unimpeded by thickets of shrubs and undergrowth, such as are found today over thousands of square miles of woodland America.

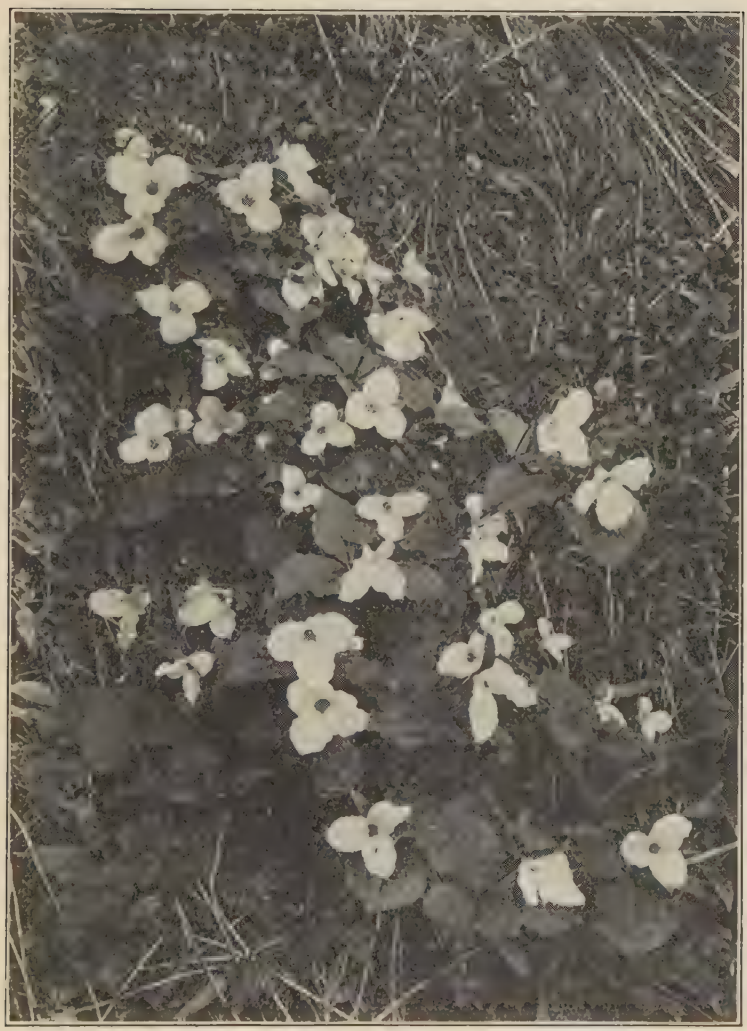
There are a few shrubs that stand the densest shade, however, and the one most persistent under the Beech-Birch-Maple is the Hobble-bush, *Viburnum alnifolium,* found throughout the park. Under the oldest and densest stand of the dominant trees it is often the only shrub. Ground Yew, *Taxus canadensis*, which is so common in this forest type in New England and the Adirondacks, is rather rare at Allegany.

Another scattered shrub is the Red-berried Elder, *Sambucus racemosa,* and often there are young trees of the Mountain Maple, *Acer spicatum*, and the Moosewood, *Acer pennsylvanicum.* While the two latter are trees, they are always under-canopy ones and, as ordinarily seen, are mere shrubby plants not over 10 feet high. They may be taller and are in some cases at Allegany, but they lack the power to crowd up into the canopy. None of them is so well fortified to stand the lack of light as is the Hobble-bush, and none of them is *always* found in the deepest parts of the forest as it nearly always is. A study of many hundreds of acres of the forest at Allegany shows the Hobble-bush to be easily the dominant and often the only shrub under mature or nearly mature stands of this kind of timber.

But in no forest is there not some opening, and in such and along their edges may be found many other shrubs. There is a list of these on page 205 of the Flora of Allegany State Park Region, and more might be added. Here we are more concerned with what lack of light does to the forest floor. The outstanding result is to restrict shrubby vegetation and outside of those already mentioned there is only a handful of species. Much more striking and of more significance is the dearth of individual plants. Scuffling over a bed of dried leaves in midsummer instead of picking one's way through a tangle of undergrowth this dearth is quite the most unusual feature of these mature Beech-Birch-Maple forests.

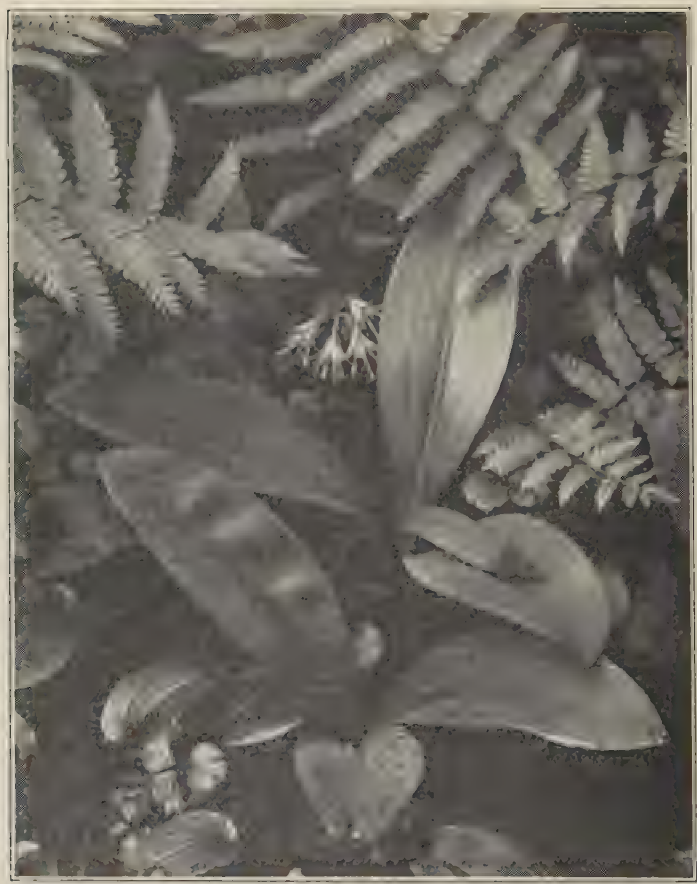
Over many acres of such forests at Allegany, the shrubs in the order of their frequency are:

Hobble-bush, *Viburnum alnifolium*
Red-berried Elder, *Sambucus racemosa*
Ground Yew, *Taxus canadensis*
Mountain Maple, *Acer spicatum*
Moosewood, *Acer pennsylvanicum*
Alternate-leaved Dogwood, *Cornus alternifolia*
Arrowwood, *Viburnum acerifolium* (figure 10)
Fly Honeysuckle, *Lonicera canadensis*
Bush Honeysuckle, *Diervilla lonicera*



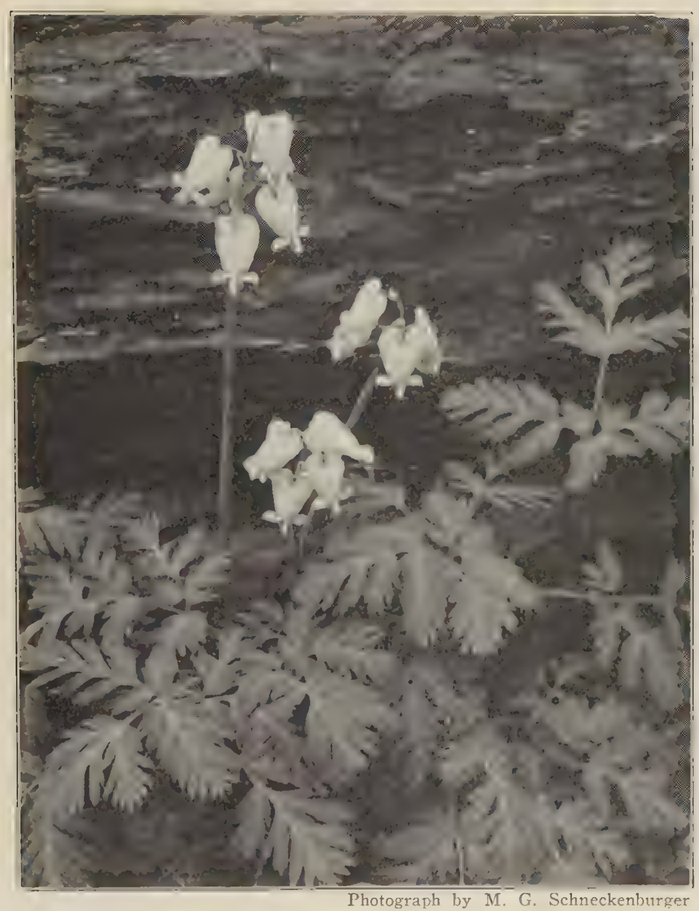
Photograph by M. G. Schneckenburger

Figure 4 Showy Trillium, *Trillium grandiflorum.* One of the showiest wild flowers under the dominant forest in the park. Tolerant of shade and the finest of all the trilliums.



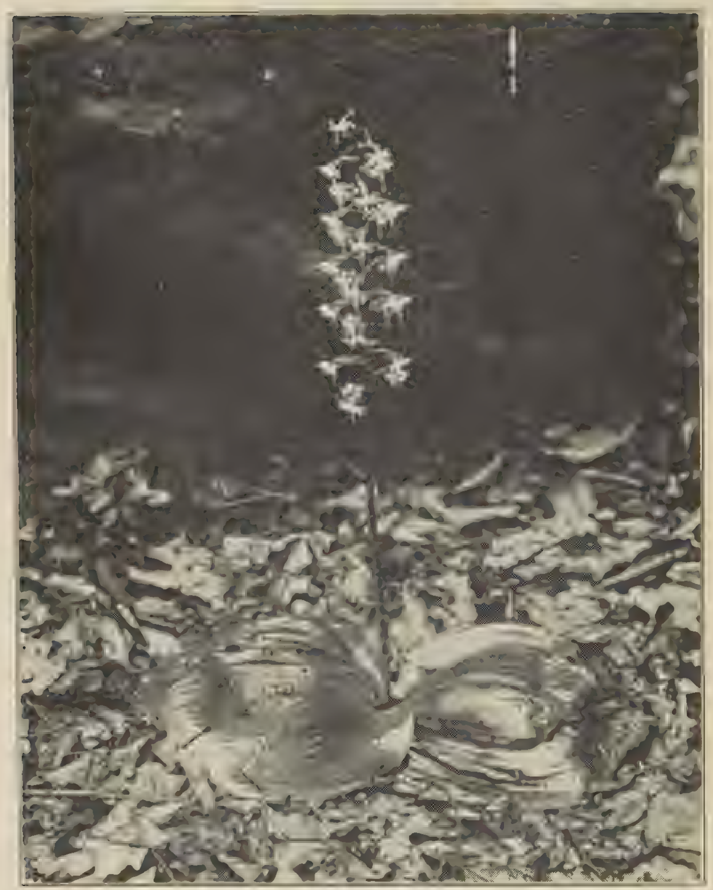
Photograph by M. G. Schneckenburger

Figure 5 Yellow Clintonia, *Clintonia borealis*. One of the common wild flowers under the Beech-Birch-Maple forest, but found in many other places in the park.



Photograph by M. G. Schneckenburger

Figure 6 Squirrel Corn, *Dicentra canadensis.* A delicate woodland perennial, well suited to the depths of the dominant forests at Allegany State Park; preferring heavy shade, freedom from wind and a rich humus soil.



Photograph by M. G. Schneckenburger

Figure 7 Round-leaved Orchid, *Habenaria orbiculata*. The two prostrate glistening leaves of this woodland orchid are characteristic of the Beech-Birch-Maple forests, and sometimes it strays outside them.

There are, of course, other scattered shrubby species, but so far as making up an appreciable part of the vegetation is concerned, they are negligible. In fact, so are most of the others in the list above, except the first two or three. By so much does the mature Beech-Birch-Maple reduce the shrubs to a mere handful that can tolerate the dense shade of such forests.

It is even more striking in the case of herbs. Hundreds are known from the park. A scant dozen are really at home in the still undisturbed areas of these great gloomy forests. And, unlike the shrubs, it is not easy to find a dominant herb, for there are several herbs that grow in considerable quantity in most of these forests, notwithstanding the fact that over many acres there is none.

If it were necessary to pick only two plants that *always* grow under the Beech-Birch-Maple, they would have to be the Round-leaved Violet, *Viola rotundifolia,* and probably the Twisted Stalk, *Streptopus roseus.* With them are often found the Showy Trillium, *Trillium grandiflorum,* the Wood Sorrel, *Oxalis acetosella,* the Foam Flower, *Tiarella cordifolia,* Partridge Berry, *Mitchella repens,* and one or two species of Club Moss, *Lycopodium lucidulum* and *L. clavatum.* This is a rather meager list of herbs for a region that is richer in wild flowers than any place that comes to mind in New York State. Again it is the effect of this dense forest canopy in restricting the forest floor herbs to those which will tolerate the greatest possible shade.

A list of these herbs, arranged in the order of their frequency, is given below, considering only those which are found under mature forest growths:

Round-leaved Violet, *Viola rotundifolia*
Twisted Stalk, *Streptopus roseus*
White Trillium, *Trillium grandiflorum* (figure 4)
Wood Sorrel, *Oxalis acetosella*
Foam Flower, *Tiarella cordifolia*
Partridge-berry, *Mitchella repens*
Common Wood Fern, *Thelypteris spinulosa intermedia*
Shining Club Moss, *Lycopodium lucidulum*
Running pine, *Lycopodium clavatum*
Ground pine, *Lycopodium obscurum*
Bellwort, *Uvularia perfoliata*
Disporum, *Disporum lanuginosum*
Yellow Clintonia, *Clintonia borealis* (figure 5)
Purple Trillium, *Trillium erectum*
Wood Nettle, *Laportea canadensis*
Gold Thread, *Coptis trifolia*
Fringed Orchis, *Habenaria orbiculata* (figure 7)
Coral Root *Corallorrhiza maculata*
Squirrel Corn *Dicentra canadensis* (figure 6)

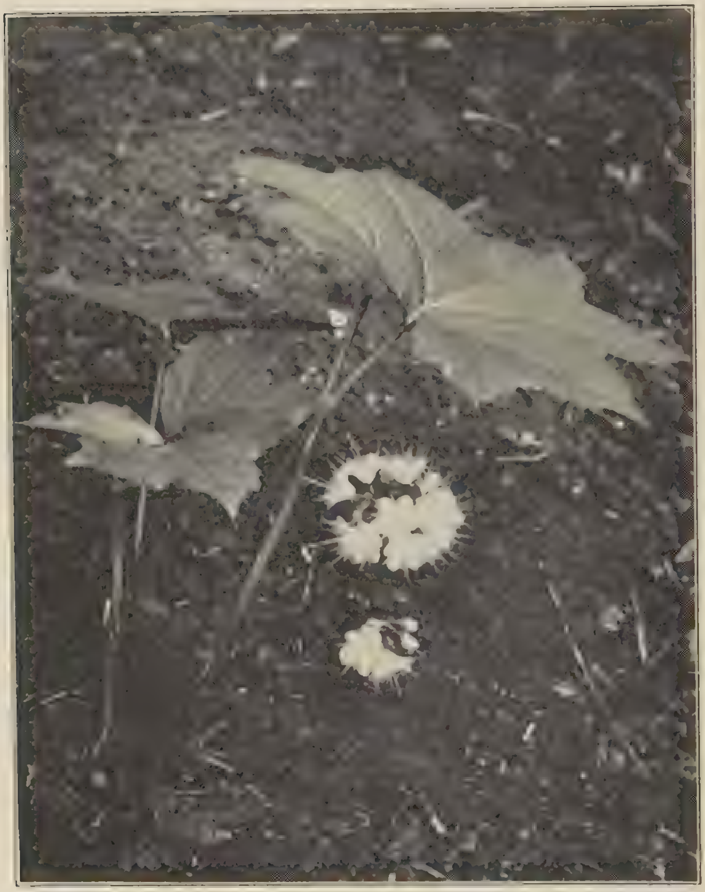
Outside of the first five in the list, and ignoring the club mosses, the rest of these herbs are apt to be scattered. With hundreds of species of wild flowers known from the park, this meager list of herbs under the Beech-Birch-Maple mature forest is surely an outstanding example of the effects of that canopy upon the distribution of the forest floor vegetation.

It requires only a slight disturbance of this canopy for scores of wild flowers to rush in and occupy areas that otherwise would not be favorable to their growth. A typical place is along the slopes of Quaker Run. There a young growth of this forest is vigorously and rapidly growing to maturity. Under it there are hundreds of square rods covered exclusively with the beautiful Waterleaf, *Hydrophyllum canadense* (figure 8), magnificent in its snowy bloom in mid-July. In other parts of this forest, depending upon soil and density of canopy, other wild flowers will capture the site. This is notably true of the Wood Sorrel, *Oxalis acetosella*, and some of the club mosses, which may be found in extraordinary luxuriance over many acres of the park. But such happy and quite thrilling accidents do not overcome the fact that, generally speaking, the herbs under the mature or close-canopied Beech-Birch-Maple forest are very limited and that light plays its part on the forest floor just as it does up in the tall roof of the forest. How profoundly light affects the distribution of herbs in the park we shall see when the very different conditions under altogether a different type of forest are realized. That type is the Oak-Hickory forest.

The Oak-Hickory Forest

While the forest just described covers most of the park, it is replaced in warmer and lower parts of the area by an entirely different assemblage of trees, different not only in species but in the ecological conditions created by them, and different too, in their origin. While the Beech-Birch-Maple is predominantly northern and consequently of cooler regions, the Oak-Hickory forest finds its home farther south and consequently in warmer parts of America.

It is not surprising then to find it along the Allegheny river, the hills bordering it, especially on the south sides of such hills, and in other places of lower elevations in the park. A few other places to be noted presently are also covered with this forest of a very different type than the close-canopied Beech-Birch-Maple. There is, too, an entirely different forest floor and, as we shall see later, an entirely different assemblage of herbs growing on it. Where the Beech-Birch-Maple seems organized to endure shade, the Oak-Hickory woods are exactly the reverse. The trees are farther apart, the canopies are always more open, the profusion of shrubbery and wild flowers is in marked contrast to the dearth of them in the Beech-Birch-Maple (figure 9).



Photograph by M. G. Schneckenburger

Figure 8 Waterleaf, *Hydrophyllum canadense* Found all over the park but in its greatest profusion near the bottom of Quaker Run, under a young but thrifty stand of the Beech-Birch-Maple forest; covering hundreds of square rods there and in full flower in mid July.

The Oak-Hickory forest is just as exclusive as the other type, but instead of shade acting as the barrier, it is excess of heat, dryness and openness which the Oak-Hickory uses to keep out intruders. There is the same relentless struggle, the same inexorable tendency to maintain the type at the expense of neighbors, and few of the shade-enduring, moisture-loving species of the Beech-Birch-Maple are able to encroach into these Oak forests. The trees associated with the Oak, none of which seems

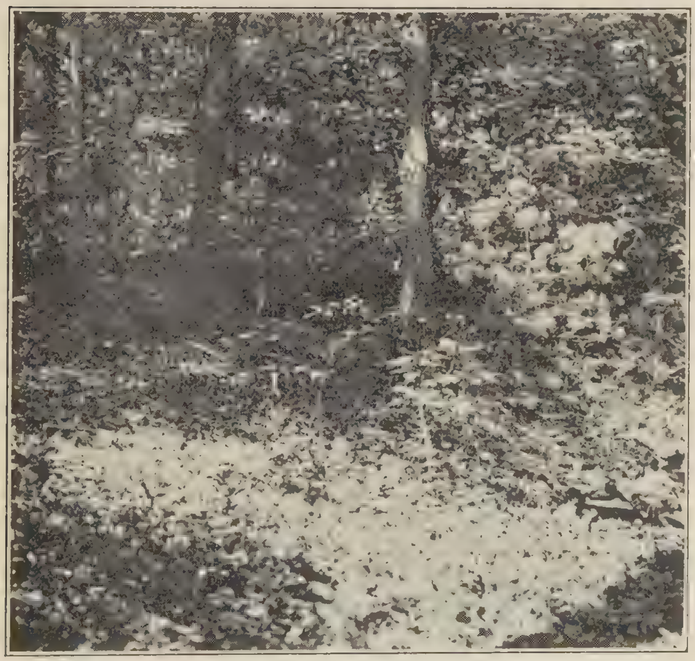


Figure 9 Forest floor and shrubby vegetation under the Oak-Hickory forest. Note its profusion and see figure 2 for contrast under the Beech-Birch-Maple forest. There is a young white pine at the right.

to be any very regular proportion of the total type, are equally well organized to withstand the full sun, the heat and dryness. And all of them seem to be united for common protection against venturesome pioneers from the Beech-Birch-Maple. The two opponents seem to be well able to take care of themselves, but fire upsets the odds more than perhaps any one factor and seems to dictate what will happen to the areas now occupied by the Oak-Hickory forest.

The dominant trees. Three species of Oak are rather common trees in this type of forest at Allegany. All are large, thick-barked sorts, and most of them have thickish, rather leathery leaves, both of which are helpful in withstanding conditions of comparative heat and dryness. The oaks are:

White Oak, *Quercus alba.* This is one of the oaks with rounded, not bristle-tipped leaf lobes, has a conspicuously grayish bark, and, when growing in the open tends to become a very wide-spreading tree. At Allegany most of the White Oaks are forest grown and none of any considerable size is likely to be found. One reason for this is that the Oak-Hickory forest occurs mostly in the lowland parts of the park, along the river, and old large trees have been taken out years ago. The tree is very common, both as a seedling and as a coppice sprout, for, like most of the trees in the Oak-Hickory forest, and to a lesser extent the Beech-Birch-Maple, it will sprout from cut-off stumps and even from fired ones if the fire has not been too severe.

Red Oak, *Quercus rubra.* This grows with the White Oak but in somewhat better soils. As the oak that grows farthest north in America, it might naturally be expected to occur in the cool forests at Allegany State Park, but it is found there mostly with the Oak-Hickory forest type and shows little inclination to push into the darker Beech-Birch-Maple. Red Oak, however, more than nearly all other trees of the Oak-Hickory forest, inhabits richer soils, grows in closer, denser stands, and in moisture requirements tends more in the direction of the Beech-Birch-Maple than toward extreme heat and dryness. We see examples of this in the proportion of Red Oak in the canopy on sites of different moisture and temperature.

Black Oak, *Quercus velutina.* As its Latin name suggests, there is a velvety quality about the leaves of the Black Oak. None of the bristle-tipped oaks in the park has the peculiar soft, velvety tufts of hairs on the under side of the leaves nor the scurfiness which is also there. These characteristics may be of no importance but their occurrence in this common component of the Oak-Hickory forest is more likely a reflection of the condition than mere accident, for hairs and scurfiness and leathery texture of leaves are all characteristics of the utmost value to trees that grow in open, relatively warm, rather dry sites. It is in just such places that the Black Oak grows and it shows less ability to compete with other trees for richer sites than does the Red Oak. That is why Black Oak is much more restricted in its distribution over the park than either the red or white kinds. On comparatively poor soils Black Oak is fairly common and on that score it shares with White Oak and certain other trees the credit of being an extremely valuable member of a somewhat fire-resistant type of forest.

Chestnut, *Castanea dentata.* Until the advent of the chestnut blight this splendid forest tree formed a large but not certainly known percentage of the Oak-Hickory forest. Today it is found throughout the Park wherever that type occurs but mostly as stump suckers, rarely as seedlings and still more rarely as mature specimens. Like its oak neighbors, it is a light-demanding tree, not fond of shade, and in consequence never found under the Beech-Birch-Maple canopy. Before fire and cutting and blight took their toll, Chestnut must have been a magnificent forest tree at Allegany. Today its importance in the forest is small; about the only significance attached to it is what has taken its place. There is every indication at Allegany that from being an important constituent of this forest type it has passed into a negligible one, and that oaks, hickories, sassafras and other trees have quietly taken over the space once occupied by the chestnut.

Hickory, *Carya sp.* There are three different kinds of hickories in the park, and the shagbark appears to be the most frequent. While the Black Walnut is unknown in the area the Butternut, *Juglans cinerea* is occasionally found in fertile lowlands, but it is the hickories that occur in sufficient numbers to be noticeable. Of these the Shagbark, *Carya ovata* is found on the drier sites, while the Bitternut, *Carya cordiformis* and the Pignut, *Carya glabra* appear to prefer more moist places. In young growths of the Oak-Hickory forest it is not always possible to tell which species of hickory occurs at a particular site, for the trees are not easy to identify in their early stages. For purposes of this report we may consider them all as simply hickories, and as such they make up an appreciable proportion of the Oak-Hickory forest. They have large, compound leaves, no fondness for shade, absolutely no ability to crowd into the Beech-Birch-Maple, and an ability to put up with rather poor sterile soils.

Sassafras, *Sassafras officinale.* With geologically the most ancient lineage of almost any tree at Allegany, Sassafras appears never quite to have made up its mind how its leave shall be lobed. Typical three-lobed leaves, unlobed ones and lopsided leaves are found in the park today, just as they are scattered through the fossil history of this extremely ancient tree. Stretching its ancestral roots back for no one knows how many millions of years does not appear to have given it stability, for it is the most variable of all Allegany trees as to leaf shape. Sassafras makes up only a small proportion of the canopy but it is found practically throughout that part of the park occupied by Oak-Hickory forest. It shows almost no ability to crowd into the Beech-Birch-Maple.

These three oaks, the chestnut, the sassafras and the hickories are easily the dominant trees in forests of this type, but there are others that form some small proportion in most such places; and at least two bridge the gap between the Beech-Birch-Maple and the Oak-Hickory. These are the Red Maple and White Pine. The former is found nearly everywhere throughout the park in one type or the other, while the White Pine is much more common as a young but up and coming constituent of Oak-Hickory forests than anywhere else at Allegany. White Pine finds its light requirements better provided for in the Oak-Hickory, although there is good evidence that it would prefer the richer, more moist sites now occupied by the Beech-Birch-Maple, into which, as we have seen, only an accident will admit it.

It is at once obvious that Oak-Hickory forests are very different from the usual, more extensive Beech-Birch-Maple, not only in spacing, light requirements and other things, but markedly different in the number of fairly important trees that make up their thin canopy. Instead of the three obvious dominants of the other type, the Oak-Hickory shows the following average composition:

Average per cent of canopy trees of the dominant species in the Oak-Hickory forest of Allegany State Park

White Oak	23%
White Pine	15%
Red Maple	14%
Red Oak	12%
Black Oak	9%
Chestnut	8%
Sassafras	6%
Hickory (3 species)	5%
Chestnut Oak	4%
Scattered	2%

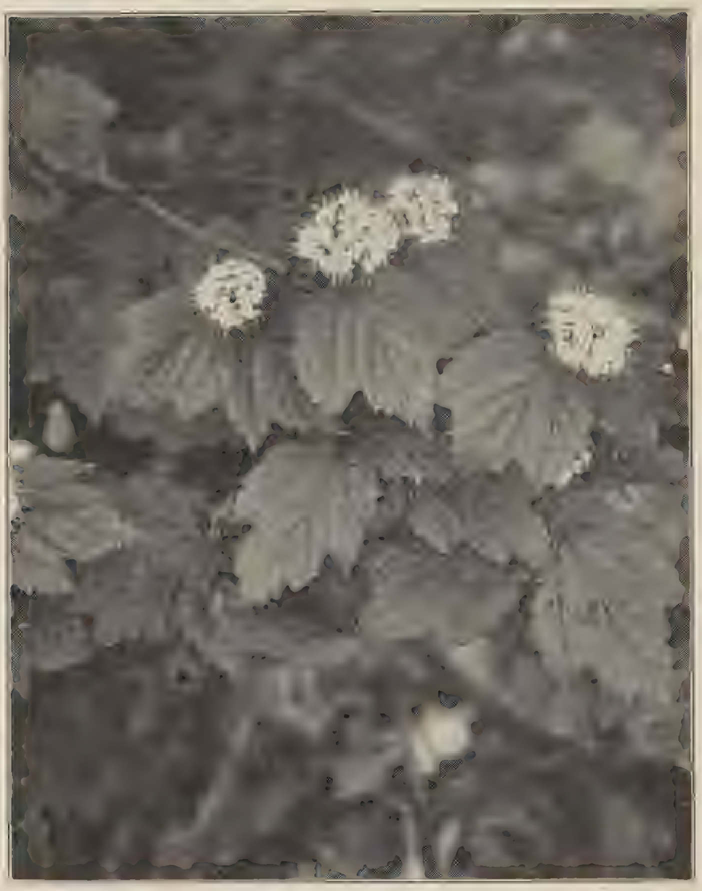
Just as in the Beech-Birch-Maple forest, these figures represent many counts over many acres of forest and they are to be considered as a guide of what to expect in the type, rather than the actual percentage at any one spot, for much more than any other forest type at Allegany, the Oak-Hickory forest's composition is sadly altered by fire and ruthless cutting, and for years there may exist a condition, common in many places in the park, where Oak-Hickory or even the Beech-Birch-Maple is scarcely recognizable as such, because of other trees that have come into the disturbed area. More will be found about this most interesting phase of park vegetation a little later.

Among scattered trees that make up only a minute fraction of the canopy of Oak-Hickory, there are four of sufficient interest to be worth noting here.

Dogwood, *Cornus florida.* The beautiful white bracts of this tree are mostly gone before summer visitors get to Allegany. In the spring it would be easy to make out its relative frequency, but later on its green berries are not conspicuous enough, until they take on the scarlet autumn coloring, to provide sure identification for those who do not know the tree. The Flowering Dogwood is nowhere very common in the park, but it is scattered everywhere in the Oak-Hickory forest, very rarely in the Beech-Birch-Maple. Someone has said that Dogwood does not like to have hot sun strike its thin bark. But at Allegany it seems to prefer the warmth and sunlight of the Oak-Hickory to the coolness and moisture of the other forest. Slow-growing, hard-wooded, only partly shade-enduring, the Dogwood is scarcely ever a tree tall enough to be up in the mature canopy of any forest. It is considered by foresters as an under-canopy tree. But at Allegany there is so much of the Oak-Hickory that is still in fairly young stages, that the Dogwood is often a canopy tree—a position it will not hold fifty years hence.

Shadbush, *Amelanchier canadensis.* Like the Dogwood, the Shadbush is not usually a tree of the canopy, but among second-growth forests of Oak-Hickory is often found there. Unlike Sassafras, the Shadbush does get into the cooler and more moist parts of the park, where its early white flowers and rosy but small applelike fruits are rather conspicuous. More commonly it is found in the Oak-Hickory woods, where occasionally this close relative of the apple is fairly common. No other tree of the rose family is so widely distributed in the park and none has such a stout, hard-wooded trunk. While it is often shrublike in its young stages, trees with trunks four inches in diameter are often seen. Later they will probably be found with trunk diameters of one foot or even slightly more.

Cucumber Tree, *Magnolia acuminata.* As it is in the Beech-Birch-Maple, the Cucumber Tree is only a



Photograph by M. G. Schneckenburger

Figure 30 Arrow-wood. *Viburnum acerifolium.* Perhaps the most frequent of the taller shrubs under the Oak-Hickory forest, but found in many other places in the park.

small part of the canopy of Oak-Hickory forests. It is more frequent than in the cooler and more moist woods, but in neither does it make up enough percentage of the total composition to be more than a botanically interesting interloper.

Shrubs and Herbs. Nowhere is the contrast between the two major forest types in the park more striking than in the wealth and luxuriance of herbs and shrubs in the Oak-Hickory, and, as we have seen, their comparative scarcity in the darker, cooler forests of the Beech-Birch-Maple.

The more open canopy, warmer sites and greater sunlight make the Oak-Hickory forests a congenial home for a host of species that never or almost never penetrate the other sort of woods. This is very noticeable in the rank shrubby undergrowth in the more open forest.

Of the taller shrubs perhaps the commonest are the Arrowwood, *Viburnum acerifolium,* (figure 10), Pinkster, *Azalea nudiflora,* Elderberry, *Sambucus canadensis,* Deerberry, *Vaccinium stamineum,* Sumac, *Rhus glabra,* and two willows, *Salix tristis,* and *S. Bebbiana.* Nor are these by any means rare, for there are often dense thickets of them occasionally tangled up with the Bittersweet, *Celastrus scandens.* These shrubs, together with a wealth of tree seedlings, give a wholly different aspect to these Oak-Hickory woods.

Even more striking is the rampant growth of low shrubs, usually not over two feet high, often less than 12 inches. There are literally millions of these, often carpeting the ground for square rods. Easily dominant are two species of Low-bush Blueberries, *Vaccinium pennsylvanicum* and *V. vacillans,* but several others run a close third or fourth in frequency, notably a low willow, *Salix humilis*, and the Sweet Fern, *Myrica asplenifolia*. What the botanists call shrubs, as they are woody plants, but are considered merely wild flowers by most people, are the Trailing Arbutus, *Epigaea repens*, and the Wintergreen, *Gaultheria procumbens*, both of which are common in the Oak-Hickory woods but not elsewhere in the park.

No mere list of the shrubs in this type of forest can convey their frequency, luxuriance, and their ability to create a vastly different aspect and incidentally a vastly different ecological environment from the all but bare, cool forest floor under the Beech-Birch-Maple. A census of these shrubs, however, is worth while, merely to compare the difference in the number of species found in two types.

Shrubs under the Oak-Hickory forest, arranged in approximate order of frequency

Taller Shrubs

Arrowwood, *Viburnum acerifolium*
Pinkster, *Azalea nudiflora*
Elderberry, *Sambucus canadensis*
Deerberry, *Vaccinium stamineum*
Smooth Sumac, *Rhus glabra*
Sage Willow, *Salix tristis*
Beaked Willow, *Salix Bebbiana*
Beaked Hazelnut, *Corylus cornuta*
Witch-hazel, *Hamamelis virginiana*
Poison Ivy, *Rhus toxicodendron*
Wild Rose, *Rosa carolina*

Lower Shrubs

Often not over one foot, some kinds as much as two to three feet high

Low-bush Blueberry, *Vaccinium pennsylvanicum*
Late Upland Blueberry, *Vaccinium vacillans*
Prairie Willow, *Salix humilis*
Sweet Fern, *Myrica asplenifolia*
Bush Honeysuckle, *Diervilla lomicera*
New Jersey Tea, *Ceanothus americanus*
Trailing Arbutus, *Epigaea repens*
Wintergreen, *Gaultheria procumbens*

There are scattered species besides these but they do not make up any appreciable part of the shrubby vegetation, as the above do over many acres in the park. Not always is the dominant species or even the indicated frequency of other plants to be found in every such forest. Sometimes one or again another will rise to dominance, but generally speaking those listed will be found in about the order of frequency shown by the list.

Few, if any, except *Viburnum acerifolium,* are capable of getting into the Beech-Birch-Maple. All of them are light-demanding and consequently intolerant of shade. They will grow in poorer, thinner humus and some of them in none at all. They are thus peculiarly well suited to come into regions that have been cut over or burned.

The herbaceous vegetation associated with these shrubs has many more species than are found under the Beech-Birch-Maple and, like the shrubs, shows affinities with a more southern type of flora. But beyond the comparative wealth of species is the enormously greater number of individuals. It is this that carpets the forest floor of the Oak-Hickory forests with wild flowers, in striking contrast to the dried-leaf condition under the other type of forest.

In those parts of the Oak-Hickory forest that have been recently cut over or burned over, two plants are apt to be dominant in the early stages, one of them for a brief period and the other for a number of years. The temporary and much the most showy of these is the Fireweed, *Epilobium angustifolium,* which often covers large areas of this sort. The other is the almost worldwide Bracken Fern, *Pteridium latiusculum,* which grows to the exclusion of anything else for some years after a fire or a cutting.

Quite apart from these two more or less temporary herbs, however, the Oak-Hickory forest has many species of wild flowers and they appear to have some order of frequency, at least in the different age classes of the forest. What follows applies to a medium-sized forest of the Oak-Hickory, and in such places easily the commonest herb is the Wild Sarsaparilla, *Aralia nudicaulis*. This shallow-rooted perennial seems best adapted to the forest floor conditions in such woods. Almost as common as *Aralia nudicaulis,* is the False Indigo, *Baptisia tinctoria, the* Cranesbill, *Geranium maculatum*, the Tick Trefoil, *Desmodium paniculatum,* the Dogbane, *Apocynum androsaemifolium,* and the White Clintonia, *Clintonia umbellulata*. Among these most common species their order of frequency would be, with a few more not yet mentioned, about as follows:

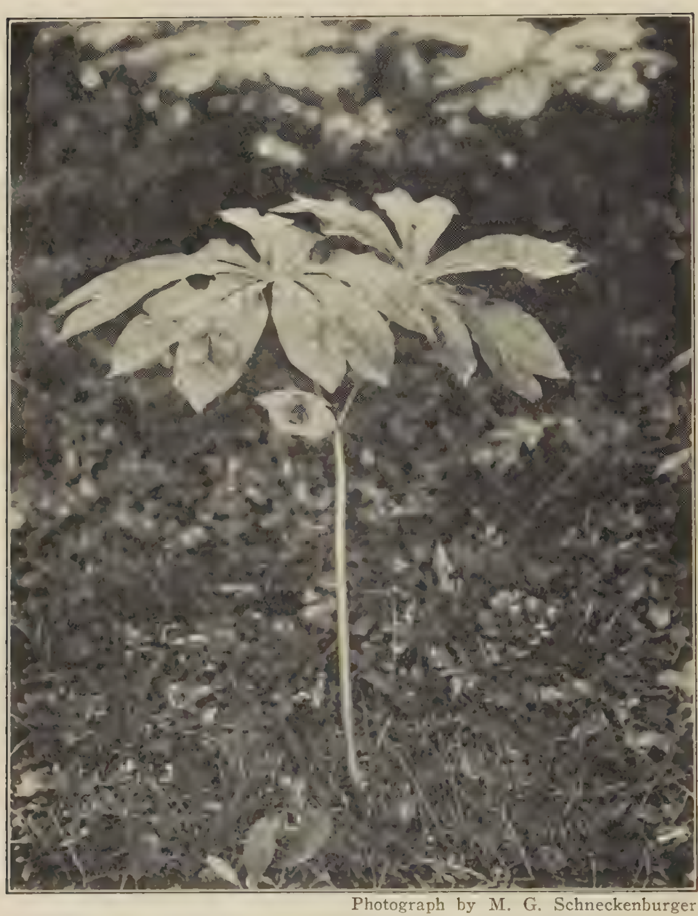
Wild Sarsaparilla, *Aralia nudicaulis*
False Indigo, *Baptisia tinctoria*
Cranesbill, *Geranium maculatum*
May Apple, *Podophyllum peltatum* (figure 12)
Tick Trefoil, *Desmodium paniculatum*
Dogbane, *Apocynum androsaemifolium*
White Clintonia, *Clintonia umbellulata*
Cinquefoil, *Potentilla canadensis*
Cowwheat, *Melampyrum lineare*
Wild Strawberry, *Fragaria virginiana*
Hepatica, *Hepatica americana*

These ten herbs perhaps make up the bulk of the herbaceous vegetation under the Oak-Hickory and it is worth noting that practically all of them come from regions far to the south of the park. This is also true of a still larger group of secondary herbs under the Oak-Hickory. While perhaps none of these is on the northern edge of its range at Allegany State Park, they certainly range down the Atlantic coast much farther south of the park than they do north of it. These secondary herbs, none of which is really rare, are arranged below in their usual order of frequency:

False Spikenard, *Smilacina racemosa*
Tick Trefoil, *Desmodium grandiflorum*
Crosswort, *Lysimachia quadrifolia*
Early Golden rod, *Solidago juncea*
Rough Goldenrod, *Solidago rugosa*
White-topped Aster, *Sericocarpus asteroides*
False Lily-of-the-Valley, *Maianthemum canadense* (figure 12)
Shin-leaf, *Pyrola americana*
Devil's-bit, *Chamaelirium luteum* (figure 13)
Wood Lily, *Lilium philadelphicum*
Lousewort, *Pedicularis canadensis*
Bellwort, *Uvularia sessilifolia*
Indian Physic, *Gillenia trifoliata*
Spring Vetch, *Vicia caroliniana*
Bush Clover, *Lespedeza capitata*
Moccasin Flower, *Cypripedium acaule*
Bastard Toadflax, *Comandra umbellata*
Indian Pipe, *Monotropa uniflora*
False Foxglove, *Aureolaria glauca*
Black Snakeroot, *Cimicifuga racemosa*
Hawkweed, *Hieracium venosum*
Meadow Rue, *Thalictrum dioicum*
Lupine, *Lupinus perennis* (figure 14)

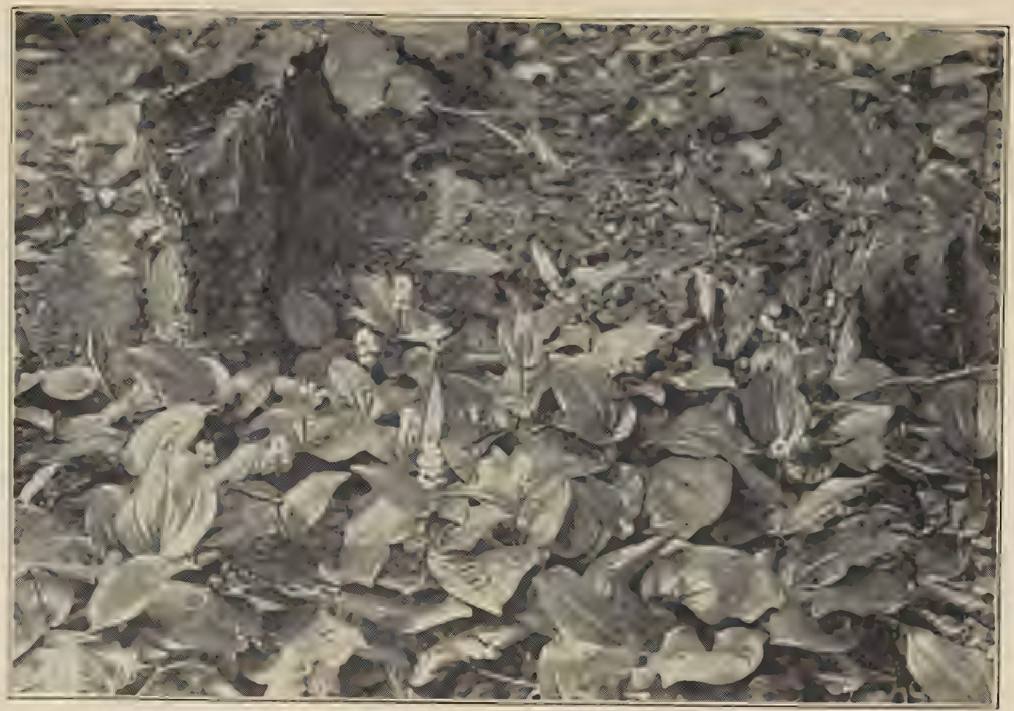
There are, of course, many other scattered species in this aggregation of herbs but to list them would give one no idea of the wealth and luxuriance of this herbaceous vegetation under the Oak-Hickory forest. Nor will even the two lists above, notwithstanding that they attempt to show relative frequency, give anyone who has not seen it any real idea of the profusion of wild flowers in such woods.

Apart from the beauty and interest of this herbaceous flora, so far out of the normal range and isolated in the park to comparatively limited sites, it furnishes one of the best indications of the forest type that can be imagined. One need scarcely know the name of a tree in the park and still be able to classify the two forest types in question by the profusion of herbs in the Oak-Hickory and the lack of them in the Beech-Birch-Maple.



Photograph by M. G. Schneckenburger

Figure 11 May Apple, *Podophyllum peltatum*. A common wild flower under the Oak-Hickory forest, and occasional under the dark canopy of the Beech-Birch-Maple. Often beaten down by bears in summer as they gather the fruits



Photograph by M. G. Schneckenburger

Figure 12 False Lily-of-the-Valley, *Maianthemum canadense.* A common wild flower under the Oak-Hickory forest and in many other places in the park; usually growing in large patches.

Both of these forest types and their associated shrubs and herbs are not peculiar to Allegany State park. Both are representative of far-flung types of vegetation that cover thousands of square miles of eastern America. Neither is exactly typical as represented in the park. Some explanation of how they fit into this country-wide scheme of vegetative belts will make the local representative of each type more interesting and their departure from the typical condition the more significant.

THE POSITION OF THE FORESTS IN THE PLANT SOCIETIES OF EASTERN AMERICA

To recognize these two types of forest in the Park, to identify individual trees in them or even to know the average percentage of these individuals in the mature canopy is a little like an average citizen being told that two foreign neighbors come from Haute-Savoie and Pamir. The average citizen, if he is intelligent and does not know either place looks them up and finds that one neighbor comes from that corner of France which thrusts itself among the majesty of the Swiss Alps, and the other from a semidesert region west of the Caspian sea in Central Asia.

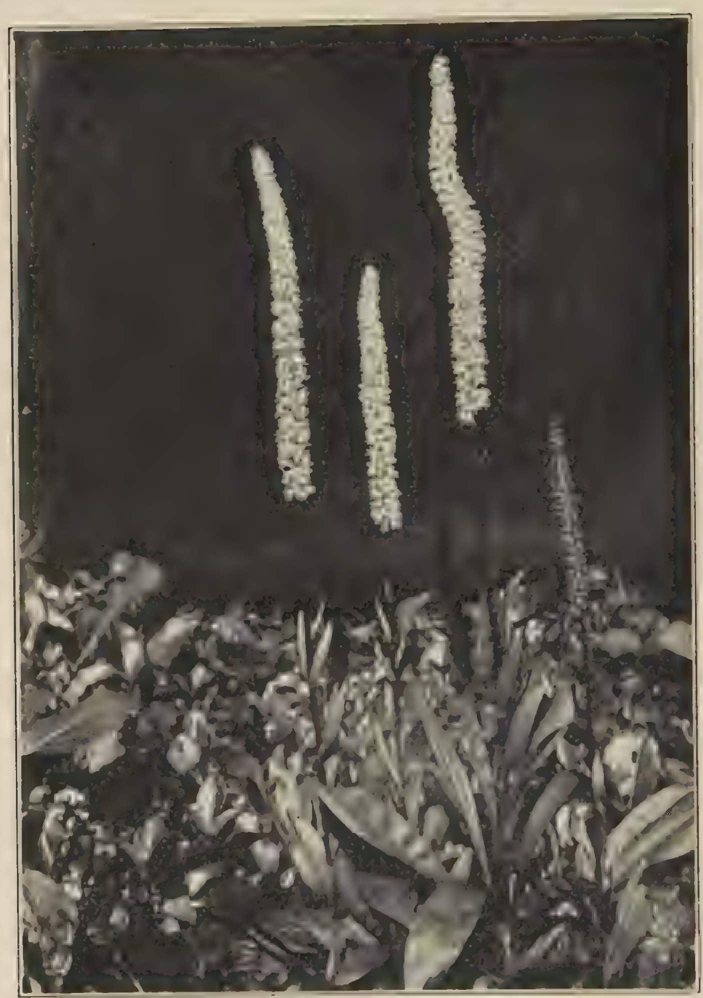
So with our plant societies at Allegany State Park. They are but part of a scheme or plan of vegetation in eastern America, the broad outlines of which are simple enough. But to understand them makes vastly more interesting the two forest types in the park.

The different plant societies in the following scheme are all spoken of as climax societies because they appear to represent the utmost that climate can produce in the areas they inhabit, and each of them possesses the power of self-perpetuation, which is one of the most necessary qualifications of a climax.

Only those climax types are included which will show where our Allegany forests fit into the general scheme. Those found in Allegany are in bold face type.

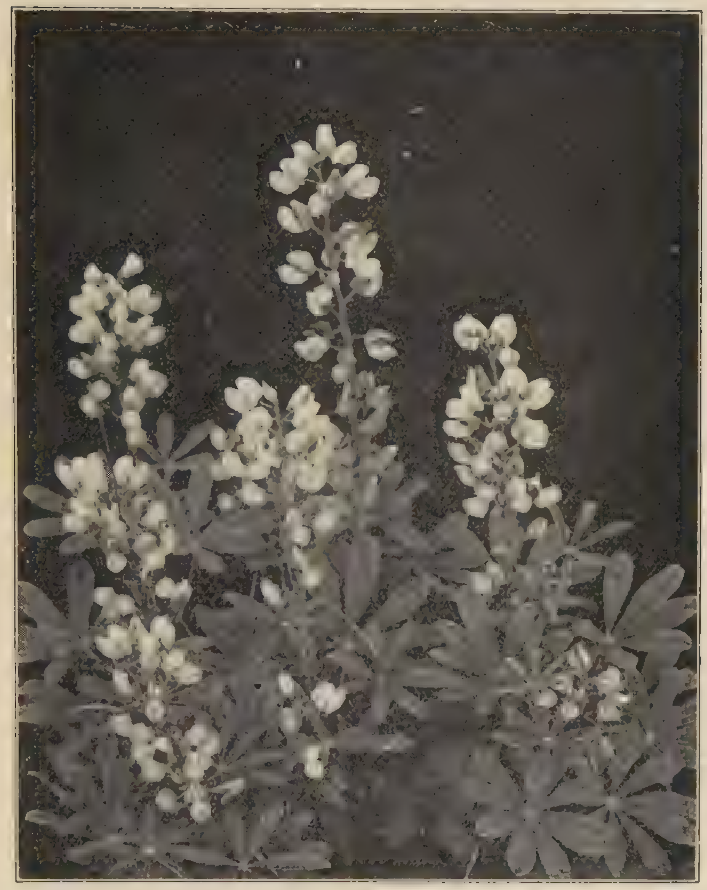
Arctic-Alpine Zone

No trees. Only low tundra vegetation growing usually over a frozen substratus. Found in northern Canada, Alaska, Arctic America, and on Alpine mountain summits (Adirondack and New England mountains).



Photograph by M. G. Schneckenburger

Figure 13 Devil's Bit, *Chamaelirium luteum*. A comparatively rare plant and mostly confined to the open-canopied Oak-Hickory forests; practically never in the cool, dark shade of the Beech-Birch-Maple forest.



Photograph by M. G. Schneckenburger

Figure 14 Lupine, *Lupinus perennis*. A beautiful blue-flowered perennial confined to the warmer, sandier soils of the Oak-Hickory forests, notably at Peter's run; rare elsewhere and never in the Beech-Birch-Maple forest.

Hudsonian Zone

Coniferous trees exclusively; mostly the Balsam Fir. Found in northern United States, in the Adirondack and New England region between elevations of 3500 and 4500 feet. In the park only at Red House valley. See page 91.

Canadian Zone

Coniferous trees, mostly the Red Spruce, some Paper Birch and some Balsam Fir and the Mountain Ash. Found in northern United States, in Adirondack and New England region between 2000 and 3500 feet elevation.

Transition Zone

Beech-Birch-Maple hardwood forest, with Hemlock or Red Spruce in the mixture. Found in northeastern America at moderate elevations, particularly in the great Allegheny plateau region.

Upper Austral Zone

Oak-Hickory-Sassafras hardwood forest, often with Tulip Tree and Hackberry in the mixture. Found from the lower Hudson valley to Chesapeake bay, at low elevation, and in occasional places north of this.

These zones are arranged from north to south and finer subdivisions of them have been considered by some writers. Of course there are still others to the southward that do not come near Allegany State Park and are omitted here. The outstanding feature of the park is that it contains representatives of Hudsonian, Transition and Upper Austral zones, but, as a forest type, none of the Canadian. There is not a single Red Spruce tree in the park and one of the mysteries of the vegetation is that the Spruce, the source of paper pulp and found over thousands of square miles in eastern America, should be wholly lacking. One of the nearly inveterate associates of the Spruce, the Paper or Canoe Birch, is also lacking in the park.

The failure of the Canadian zone to have representation in the park is still more extraordinary when it is emphasized that the Hudsonian zone is represented, not very vigorously it is true, but still it *is* there. And lower down in the scheme, of course, there are the two best represented ones, the Transition zone, with the Beech-Birch-Maple, and the Upper Austral zone with the Oak-Hickory forest.

Topography and soil may perhaps explain the lack of the Red Spruce but actual studies of this are necessary before hazarding an opinion. The facts are remarkable enough to note for the present.

One other feature of these plant zones is worth attention here—the example of the Hudsonian zone in the park. The only place where it is found is in Red House valley, about 1000 feet north of the road and about one mile west of the McIntosh road to Salamanca. Here are the only Fir trees in the park, and more will be said of these lonely outposts of a "foreign" type of vegetation a little later. See page 91.

Temperature relations. Because the Transition and Upper Austral zones are the ones best represented in the park, their ecology is naturally the most interesting and they should illustrate differences in the environment if the whole scheme is sound. This and many other attempts to arrange plant and animal life in America into broad belts stretching from Arctic tundra to tropical tip of Florida, are based for the most part upon differences in temperature.

Upon such a scheme, of course, the Transition or Beech-Birch-Maple should be in the cooler parts of the park, and the Upper Austral in the warmer. There are no continuous observations over a period of years to prove this, but during the summer of 1927 thermometers were set out in the Beech-Birch-Maple forest at the Allegany School of Natural History and in the Oak-Hickory forest near Quaker Bridge, eight miles westward. The record and elevation at the different stations follow:

Temperature record in two forest types, Allegany State Park, 1927

WEEK ENDING	BEECH-BIRCH-MAPLE AT THE SCHOOL, ELEVATION 1875 FEET [1]			OAK-HICKORY NEAR QUAKER BRIDGE, ELEVATION 1550 FEET [2]		
	Maximum	Minimum	Variation	Maximum	Minimum	Variation
July 23d	78° F.	47° F.	31° F.	83° F.	42° F.	41° F.
July 30th	76	51	25	84	49	35
August 6th	73	35	38	77	35	42
August 13th	72	36	36	79	37	42
August 20th	75	35	40	81	36	45
August 27th	73	34	39	77	35	42
Average	74.5	39.6	34.8	80.1	39.0	41.1

While these variations in temperature may not appear impressive they show some interesting comparisons between the Transition and Upper Austral zones as they are represented in the park.

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[1] The thermometer station at the school was on the north side of a Sugar Maple tree about 100–125 feet south-southwest of the water tank and pump and near the trail up the hill.

[2] The Oak-Hickory station was on the north side of a Red Oak tree about three-quarters of the way up the southwesterly facing slope of the hill immediately east of Quaker Bridge village. The hill has no name on the maps, and was pointed out to me as Huckleberry hill, which is on the maps but about a mile northeast of the hill upon which the temperature readings were made. There is no trail to the thermometer station, which could best be found by its elevation, 1550 feet. See figure 15.

Comparison of average summer temperatures, Allegany State Park, 1927

	MAXIMUM	MINIMUM	VARIATION
Upper Austral Zone			
Oak-Hickory forest..........	80.1° F.	39.0° F.	41.1° F.
Transition Zone			
Beech-Birch-Maple forest....	74.5	39.6	34.8

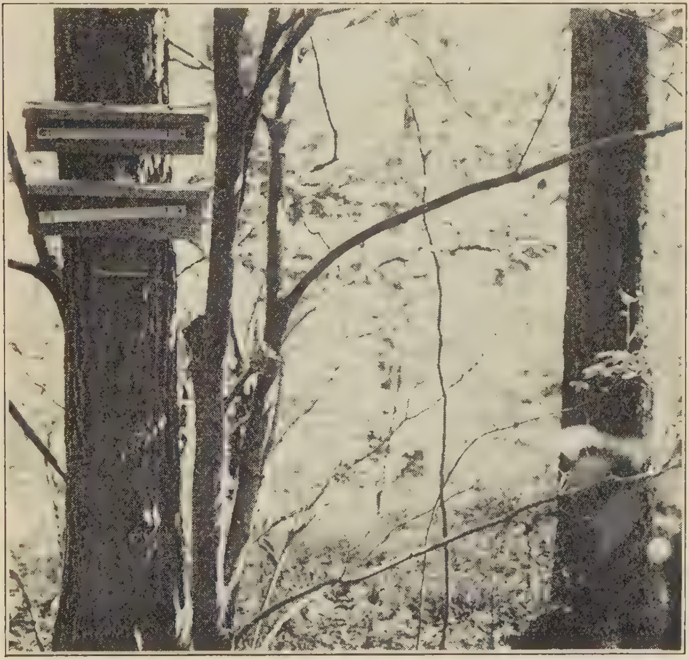


Figure 15 Temperature station in the Oak-Hickory forest near Quaker Bridge. Duplicate sets of maximum and minimum thermometers of the U. S. Weather Bureau type were also set up under similar conditions under the Beech-Birch-Maple forest at the Allegany School of Natural History. See text for results of the weekly readings of these from July 23–August 27, 1927.

The general assumption that the Oak-Hickory forest is found in the warmest sites in the park appears to be indicated by the much higher maximum temperature there. A glance at the minimum figures, however, and particularly at the weekly ones shows that the night temperatures are slightly lower in the Oak-Hickory forest than at the Beech-Birch-Maple, possibly due to cold air drainage down the valley of Quaker run or perhaps to the fact that the canopy of the Beech-Birch-Maple is so much more dense than the Oak-Hickory that it acts as a protective blanket. The most striking temperature difference between the two forest types is the variation or range between night and day temperatures. An average range of 41.1° F. at the Oak-Hickory is perhaps the best expression of the canopy of that forest that one could get without an elaborate set of instrumental records, for here is a measure of what this particular forest type is doing to the sites it occupies. Minimum temperatures at both places appear to be fairly uniform, with slightly lower ones at the Oak-Hickory. The considerably higher maximum and greater range between high and low temperatures are unquestionably due not alone to basic air temperature difference between the school and Quaker Bridge but to the response of the vegetation to these differences and the production of a forest type where such differences and the larger daily range are perpetuated.

This is perhaps a complicated way of saying that Oak-Hickory prefers warmth and the Beech-Birch-Maple coolness. The position of these two forest types in the general scheme of vegetation indicates this and there would be nothing more to be said about it *if* the Oak-Hickory forests were always confined to the presumably warmer valleys. That is not always true, however, for wherever there has been a clearing, and fire follows that clearing and certain soil conditions are favorable, the area will be occupied by Oak-Hickory forest or some modification of it, and this in some of the highest and therefore presumably coolest sites in the park. What appears to happen is that once the forest is cut off or burned off, the immense amount of sunlight which is thus enabled to get through to the forest floor raises the temperature apparently to favor the Oak-Hickory as against the other type.

It is of interest, also, to trace the differences between these forest temperatures at Allegany and those kept at neighboring weather bureau stations. Both sets of my records were taken under shelters consisting of overhanging boards nailed to tree trunks, with standard weather bureau thermometers of the maximum and minimum type. These records at Allegany State Park forests, under which, incidentally, practically all camping is done, are therefore an excellent illustration of how altitude and forest cover profoundly affect temperatures.

The comparison of these forest temperatures at Allegany with places in the western part of New York and adjacent Pennsylvania, even for the brief period possible, shows some rather extraordinary climatic facts about the park. The places selected for comparison are Addison, Steuben county, N. Y., Warren, Pa., Buffalo, N. Y., and Erie, Pa. All are less than 100 miles from the park.

Maximum Temperatures, Allegany State Park Forests and Vicinity, July and August 1927, and Annual Summary

	ALLEGANY STATE PARK		BUFFALO, N. Y., ELEVATION 767 FT	ERIE, PA., ELEVATION 713 FT	WARREN, PA., ELEVATION 1180 FT	ADDISON, N. Y., ELEVATION 990 FT
	Beech forest, elevation 1875 ft	Oak forest, elevation 1550 ft				
Week ending						
July 23d	78° F.	83° F.	82° F.	82° F.	87° F.	92° F.
July 30th	76	84	80	87	90	91
August 6th	73	77	76	79	80	84
August 13th	72	79	82	85	86	89
August 20th	75	81	77	76	80	79
August 27th	73	77	80	78	82	89
Annual mean temperature	43.0		44.1	47.0	45.9	45.5

See page 60 for the exact location of the stations for temperature records at the park. The rest are weather bureau stations.

Here the effect of the Beech-Birch-Maple forest on the maximum summer temperatures is at once obvious. None of the other records either in the park or out of it, is so low as under the canopy of the Beech forest.

With less than 325 feet difference in elevation, the Oak-Hickory forest is consistently higher, so far as maximum temperatures are concerned. How much this is due to elevation and how much to the more open canopy can not be stated without further and more complete studies. At any rate, the general proposition of the response of the more southerly type of forest being in the warmer sites seems to have this instrumental backing.

The general difference between the annual mean temperature at Allegany and the other places is perhaps to be expected, for the park is higher than any of them and its winter temperatures are lower. In fact, its minimum temperatures during the summer of 1927 and perhaps in most other years are extraordinarily low. The table of minimum temperatures follows:

Minimum Temperatures, Allegany State Park Forests and Vicinity, July and August, 1927

	ALLEGANY STATE PARK		BUFFALO, N. Y., ELEVATION 767 FT	ERIE, PA., ELEVATION 713 FT	WARREN, PA., ELEVATION 1180 FT	ADDISON, N. Y., ELEVATION 990 FT
	Beech forest, elevation 1875 ft	Oak forest, elevation 1550 ft				
Week ending						
July 23d	47° F.	42° F.	55° F.	57° F.	50° F.	46° F
July 30th	51	49	59	61	52	54
August 6th	35	35	57	53	45	41
August 13th	36	37	55	52	50	42
August 20th	35	36	51	56	43	42
August 27th	34	35	52	49	42	40

See page 60 for exact location of temperature stations in the park. The rest are weather bureau stations.

Such figures as these, particularly with relation to those in Buffalo and Addison, N. Y., and Erie and Warren, Pa., show most emphatically that the cool summer nights in the park are noteworthy. The camping and resort value of the park may in the end equal that of any similar area in the State. Such summer coolness is to be found in only one or two other places in the State--the higher Adirondacks. Once this becomes generally known the park may become a mecca for city dwellers.

The fact that the minimum temperatures in the park are remarkably close to each other is also of interest. In other words, from this meager evidence alone it is justified to state that the Beech-Birch-Maple is distributed rather with relation to the cool maximum temperatures than the minimum. Oak-Hickory appears to be able to stand just as much summer coolness as the Beech-Birch-Maple and it also tolerates much more heat as the maximum figures pretty clearly show.

Rainfall. As to rainfall, the forests, if not the campers, are exceptionally fortunate. The Beech-Birch-

Maple is a moisture-loving type of forest and will thrive only where there is an abundant supply. The rainfall figures for July and August, the totals for those two months, and the average annual rainfall for the park and the same neighboring cities are given in the following table:

Rainfall (in inches), Allegany State Park and Vicinity, July and August, 1927, and Average Annual

	ALLEGANY STATE PARK	BUFFALO, N. Y.	ERIE, PA.	WARREN, PA.	ADDISON, N. Y.
July 1927	6.65 in.	5.50 in.	4.83 in.	5.05 in.	3.92 in.
August 1927	1.91	1.84	1.21	2.63	3.02
Total for July and August 1927	8.65	7.34	6.04	7.68	6.94
Average annual rainfall	42.61 (Average of 1925 and 1926)	36.28	38.55	43.44	33.15

There has been considerable discussion as to whether the park is the rainiest part of the State. Of course it is nothing of the kind. Even during the summer of 1927, which was exceptionally wet nearly everywhere in the eastern states, the park's total of 8.65 inches for July and August was only about half of that on Long Island, where during the same months there was the unheard amount of 16.90 inches of rain.

What the figures do show plainly is that the park does have more rainfall than places in the immediate vicinity, due, no doubt, to its elevation. The relatively high rainfall is perhaps the most helpful of all the climatic factors in the park for the growth of trees, accumulation of humus, profusion of wild flowers and general luxuriance of the vegetation. More important still, it is of enormous significance in checking fires or in making them impossible to start. A copious summer rainfall is moreover of profound importance in those changing phases of the vegetation which have been reserved for a separate chapter.

Evaporating power of the air. Of course temperature, wind, rainfall or any other climatic factor is not individually responsible for the occurrence or nonoccurrence of any particular type of forest. For trees, like humans, do not react to any one of these but to the totality of them. Some measure of all these changes of heat and cold, moisture and dryness, sunshine and shade, and wind movement would tell us more about the real things in the atmosphere that affect plant life than any series of isolated records such as have been presented for the park.

It has been found by experiment and observation that there *is* a method of measuring the totality of these climatic factors by an instrument called an atmometer, literally a meter of the atmosphere. The instrument is extraordinarily delicate and records most accurately the *evaporating power of the air,* or for short, the evaporation.

It is precisely to this evaporating power of the air that plants are most sensitive, and changes too drastic or too sudden in it spell disaster for most plants. Not only does the evaporating power of the air operate locally, as we shall see presently, but it operates on a tremendous scale over wide sections of the country. Where the evaporating power of the air is too high and rainfall too scanty there are prairies--or even deserts, and as the rate is reduced certain semidrought-resistant trees find a foothold. From these drought-resistant types to the climax forest in a region like Allegany one may find every gradation.

No atmometers were set up at the park during 1927, but much experience with them elsewhere makes it safe to say that the evaporating power of the air is rather low in the Beech-Birch-Maple, rather high on freshly cut and cleared land, but nowhere, due to copious summer rainfall, is it high enough to endanger the perpetuation of the forest, as it does in many parts of the United States. The forests, however, do appear to respond to temperature, evaporation and rainfall in expected and almost predictable ways. In a region like the park, both have been much subjected to disturbances of cutting, fire and less so from storms, so that both the Beech-Birch-Maple and the Oak-Hickory forests are to be found in all stages of this interference with their normal development. This interruption of the steady progress toward the climax condition is most clearly shown by the percentage of trees that in many ways are as important as any that have been mentioned so far, for it is upon the work of these pioneer, and, as we shall see, temporary trees, that the permanent climax forests depend.

What does happen at Allegany is that purely local conditions of evaporation are changed rapidly by cutting and fire, and the severity of these changes in evaporation do often dictate the speed of recovery or the type of vegetation that will first get its start. Instrumental demonstration of this is necessary before one can be more definite.

CHANGING PHASES OF THE FOREST

If forests were so many books and if once classified and cataloged they remained so, this account of the vegetation could end here and now. But they are far from being stable and permanent, even when they have reached the climax stage of their development. Storms, fire, cutting, to mention only recent or present forces of change, all tend to disturb the perfection of that climax condition and most of all interrupt progress toward it.

Two major climax types are easily recognized in the park, and as we have seen, they have a fairly definite composition.

All through the park, except in places occupied by the climax forests, there are thousands of specimens of the Aspen, *Populus tremuloides,* the Large-toothed Aspen, *Populus grandidentata,* and the Pin or Wild Red Cherry, *Prunus pennsylvania,* which is often called the Fire Cherry. This trio of pioneer trees are remarkable in the fact that they often occupy extensive areas for a few years, reach their maturity and, having served their purpose, are weeded out by the inexorable march of development. Finally the very land which they have been preparing for their successors knows them no more and they are repaid for their preparatory work by being themselves destroyed. That is one of the most interesting steps in the development of these two major, one could almost call them aristocratic, plant societies at Allegany.

Besides the pioneer trees there are a few shrubs that can stand the conditions and consequently do their part in building up the site for better vegetative types that will follow. One of the shrubs is the Sumac, *Rhus glabra;* another is the Beaked Willow, *Salix Bebbiana,* and in some particularly dry and open places are patches of the Pinkster, *Azalea nudiflora.* There are several others, notably the Sweet Fern, *Myrica asplenifolia;* the Prairie Willow, *Salix humilis,* and often thickets of Blackberry occupy such places for a brief stay, always giving way to whichever climax type ultimately captures the site.

As we have seen, like all aristocracies, these two forest types are rather exclusive, and if left alone tend to be self-perpetuating. But they are not left alone and then begins a long and often tedious process of preparing the ground for the two climaxes to capture the park again. That preparation is almost wholly done by these pioneer trees which, like all pioneers, are not particular about site or food, or heat or cold, and again, like pioneers, are not only likely to, but certainly will be pushed out of the way after their work is done.

Because of their importance and their ability to stand poor conditions, and their extermination after going through with their allotted task, the Aspen, the Large-toothed Aspen and the Pin Cherry are nearly the most interesting trees in the park.

After fire has destroyed most of the humus, the condition of heat and dryness make the immediate reproduction of Beech-Birch-Maple impossible. Their seedlings, being shade-enduring, are also decidedly not at home in the hot, dry débris that follows fire. In such places, after a succession of herbs has come in, the practically universal trees are this trio of pioneers. They not only can stand the condition that the climax seedlings can not, but they thrive under them. All the trio are absolutely light-demanding and hopelessly intolerant of shade; and it is this intolerance that spells their doom, for after a few years they have deposited enough successive generations of leaves and twigs to build up the humus under them. In this humus the seedlings of the climax trees begin to get a hold. There is, then, for a few years, a bitter struggle for the permanent occupancy of this land. The Aspens and Pin Cherry are at first overwhelmingly dominant, and a fire or two may prolong their sway for years, but in the end, and especially since the establishment of the park and the reduction of the fire hazard, they are doomed.

Nothing in the ecology of the park vegetation is so striking as this contest between these pioneers and the ultimate climax types. All over the area it is easily seen, and one of the most interesting things that a visitor can do is to count the frequency of the pioneers and climax trees. Every gradation can be found from 100 per cent pioneers to 100 per cent climax, but there is one tremendous difference between them. Under the mature Beech-Birch-Maple it is rare indeed to find a seedling of either of the Aspens or of the Pin Cherry, while under an exclusive forest of the latter trees it is still more rare *not* to find some seedlings of the climax trees. Here is perhaps the best illustration of the difference between a pioneer and climax type of forest. The pioneer is unable to, and without repeated fires never can provide for its own perpetuation, while the climax forest always does so.

Some causes of these changes. It would be interesting but not very accurate speculation to say definitely what the forces are that determine this constant ebb and flow of the forests, either toward the two major climax types or retrogressively toward the Aspen-Pin Cherry and consequently weedy forests. Without a careful study, extending over a series of years, with marked plots, it is impossible to say precisely what is happening and the cause of it in any particular place. The composition of the climaxes, their general position in the vegetation of eastern America, their ability to maintain themselves and the tendency to keep out intruders, we have seen.

Change and decay, fire and storms are constantly at work in upsetting the perpetuation of either of these climaxes, and, ever on the lookout to capture new or recently cleared sites, the Aspen-Pin Cherry forest society will play the rampant upstart. Besides the major factors of temperature and rainfall, both of which affect the development of the climax types as well as the Aspen-Pin Cherry temporary society, there are two important factors that may weigh rather heavily in dictating what is happening. These are cutting and fire, on the one hand, and soils, on the other. While they may not at first seem related, actually they are, because cutting and fire both change or may even destroy the surface humus with startling effects upon the vegetative destiny of a site so disturbed.

Cutting and fire. Wherever forests are cut there results immediately a tremendous change in the forest floor, particularly when the Beech-Birch-Maple woods are cut off. The enormously increased sunlight, the greater heat, higher evaporation and exposure to wind, may well make the forest floor a place no longer fit to reproduce the type that was cut, and exactly this has happened in many places in the park. A south-facing hillside, for instance, once dominated by the Beech-Birch-Maple may, when the forest is cut off, do one of two things. Either it will come up to a mixture of Oak-Hickory and Beech-Birch-Maple, depending upon exposure and other things, or it may, if too dry or hot, come up exclusively to Oak-Hickory. The latter may maintain itself for years, but ultimately, if climatic conditions are really of the Beech-Birch-Maple type, that forest will come into its own again. This is why over many acres of the park there is an apparent mixture of these climax types, although it appears that such a mixture is really only temporary and will go back to its true type if left alone long enough and *if* fire is kept out.

On other sites, especially north or east-facing slopes

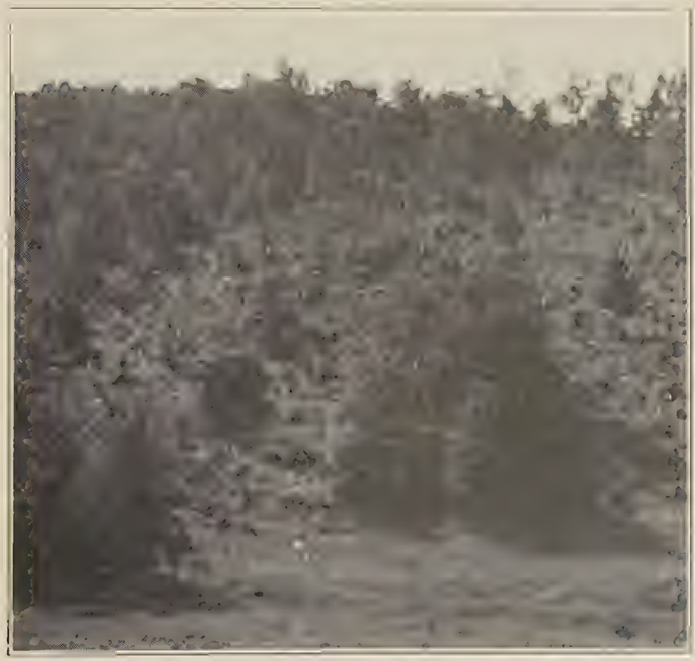


Figure 16 Example of reasonable cutting in the Beech-Birch-Maple forest. Fire was kept out of this, and consequently a dense reproduction of canopy trees has captured the area. The quaking Aspen and Large-toothed Aspen did not get temporary control of this region as they have over so much of the park. Compare figure 18.

and sometimes on others, the Beech-Birch-Maple, after a clean cutting, will reseed at once and come back in nearly pure stands and with the expected percentages of the canopy trees. Many places in the park, notably at the head of Cain's run, on Lookout hill, near the fire tower on the Salamanca road and dozens of other sites, the persistence of Beech-Birch-Maple seems assured in spite of wholesale cutting in years gone by. Temperature and especially a copious summer rainfall seem particularly favorable for the reëstablishment of the Beech-Birch-Maple if only fire is kept out (figure 16).

One instance may be worth citing. Near the head of Cain's run there is a large hillside that was cut over in 1905. Mr. Cain, for whose family Cain's run was called, assured the writer that after this cutting there was no fire and natural forest reproduction was allowed to take its course. The results, which can be matched at many other places in the park, illustrate the extraordinary quickness of the recovery of the forest if only fire is excluded.

Today the hillside is covered by a dense thrifty stand of almost typical young Beech-Birch-Maple forest. The trees range from three to five inches in diameter and are about 30 feet high. An accurate tally of this forest shows the following percentages of canopy trees:

Sugar Maple	30%
Yellow Birch	20%
Beech	15%
Red Maple	20%
Hemlock	5%
Black Birch	5%
Scattered other trees	5%

The associated shrubs and wild flowers are already just what we have seen them to be in the Beech-Birch-Maple forest, the cutting of which was done with such care that seed trees of all dominant species were left.

On many abandoned farms the recovery of the Beech-Birch-Maple is also decidedly rapid (figure 18).

It is quite otherwise where this cutting has not been for the best interests of the forest or where fire or heavy grazing has followed (figure 17). There, as at the junction of the Bradford-Salamanca roads, where there is a triangle caused by this junction, we find an entirely different type of vegetation. We have already seen the

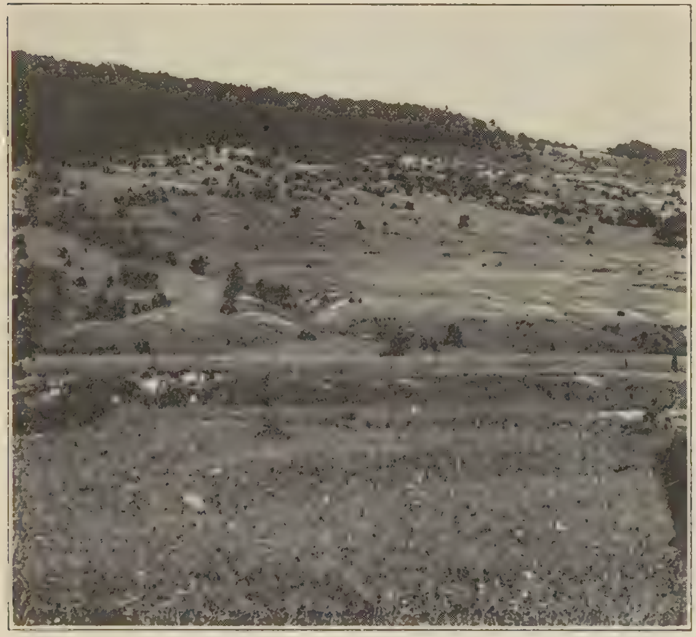


Figure 17 An example of clean cutting and the effects of grazing. It is not always fire that interrupts the normal development of the climax forest. Here, near the south end of Cain's run, the adjacent dense forest of Beech-Birch-Maple has given up ineffectual attempts to capture this overgrazed pasture, which is now abandoned to thorn bushes. All the isolated shrubs in the field are species of *Crataegus*. Compare figure 18.

predominance of weedy trees in such places, but the luxuriance of an entirely different type of herbaceous vegetation is just as noticeable.

If we can, as appears certain from the evidence, arrange our wild flowers as we have the trees, upon the basis of their moisture requirements, temperature requirements and intolerance of shade, then we have a progressive scale from the herbs of the Beech-Birch-Maple

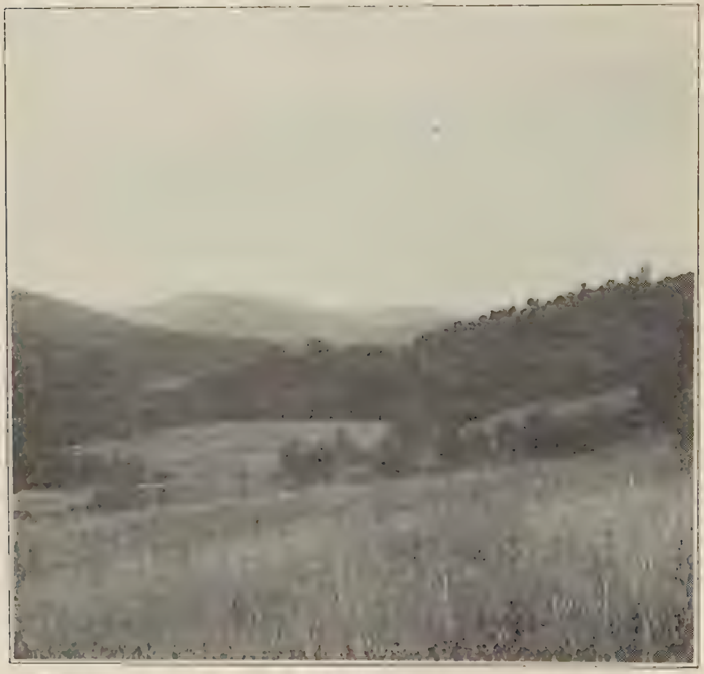


Figure 18 The capture of an abandoned farm by the dominant Beech-Birch-Maple forest near head of Lonkto hollow. Since the establishment of the park and reduction of the fire hazard fields like this are constantly being swallowed up by the encroachments of the dominant forest.

down through those of the Oak-Hickory to these sturdy and relatively indifferent herbs found in recent cuttings and after fire. As we shall see, scarcely one of these is found in the Beech-Birch-Maple, but a few of them do persist in the Oak-Hickory forest.

It is in these cut-over and burned-over areas that practically all the weeds in the park are found, outside of pasture and barnyard species. Because roadsides are often cut, graded, etc., we find the same conditions along many of them also.

In such places the Fireweed and Bracken are always the first to come up, and in the case of the former it often persists for years. Found nearly throughout the world in such places it perfectly fulfils its rôle of being one of the chief vegetative pioneers at the park. If, as sometimes happens, there are successive fires, the tough wiry stems and rootstocks of the Bracken are the only herbaceous plants that can survive. That is why it covers many acres in the park, and why, like the weedy trees, it is doomed to pass.

Next to the Bracken one of the commonest herbs of such places is the Wild Sarsaparilla, *Aralia nudicaulis*, followed by two hawkweeds, *Hieracium aurantiacum* and *H. florentinum*, and the Pearly Everlasting, *Anaphalis margaritacea*. Here also one often finds the bristly species of Wild Sarsaparilla, *Aralia hispida*, and nearly always the Wintergreen, *Gaultheria procumbens*. Other herbs, mostly weedy, found in these dry open sites, often nearly or quite lacking in humus, are:

Rough Goldenrod, *Solidago rugosa*
Mountain Aster, *Aster acuminatus*
Sweet-scented Bedstraw, *Galium triflorum*
False Solomon's Seal, *Smilacina racemosa*
Dogbane, *Apocynum androsaemifolium*
Yellow Clover, *Trifolium agrarium*

Sorrel, *Rumex acetosa*
Yarrow, *Achillea millefolium*
White Daisy, *Chrysanthemum leucanthemum*
Wild Strawberry, *Fragaria virginiana*
Blue-eyed Grass, *Sisyrinchium gramineum*
Partridge Berry, *Mitchella repens*
Ground Pine, *Lycopodium obscurum*
White Wood Aster *Aster divaricatus*
Blue Wood Aster, *Aster cordifolius*
Forked Panic Grass, *Panicum dichotomum*
Thin Grass, *Agrostis perennans*
Slender Rush, *Juncus tenuis*

There are, of course, many others but these are apt to be the commonest herbs on these least favorable sites in the park. An examination of earlier lists shows that few of these persist even into the Oak-Hickory stage of the development of the vegetation and practically none in the Beech-Birch-Maple. Like their tree associates they live in comparatively poor soils, often without humus, and while doomed to die, play a tremendously important rôle in building up the fertility of the site.

For pioneer plants are to be looked at not as permanent residents but as agencies of up-building. Upon this score these all but weedy plants and often actually roadside weeds are of tremendous importance in the vegetative economy of the park, for upon them depends the gradual resumption of that age-old process of recovery from the old disastrous days of fire and cutting. They and many other species associated with them bring about the transition from bare mineral soil to the creation of a humus layer capable of the production of the climax forest types in the park. As we have seen, these can not be expected to grow on these burnt-over lands without years of preparation, years literally of soil building. Upon the success of this process—and adequate summer rainfall is making it a conspicuous success at Allegany—the future of the climax forest depends. Of course the fundamental nature of the mineral soil in the park is not changed by this process of up-building, for only a few forest trees germinate in mineral soil but in the humus layer above it. And it is exactly this humus layer that these pioneer plants create. What they do to it and some account of the soils in the park and what both mean in the distribution of the vegetation, follows in the next section.

SOILS

As in all forested regions, there are two types of soil to be considered: one is the mineral soil undisturbed by vegetation and consequently free from humus, and the other is the humus itself. The first is the result of geological processes described in the New York State Museum Handbook 1, by Dr A. K. Lobeck, entitled A Popular Guide to the Geology and Physiography of Allegany State Park, and need not be repeated here. The other is the result of what vegetation itself does to the site, for it is upon the building up of a humus layer that the establishment and perpetuation of the forests depend.

Taking first the mineral soils, as they are the fundamental substratum of the area, it is obvious that these differ considerably over different parts of the park. Their most important differences are in the fineness of the soil particles, for it is upon this property that the capacity of a soil to hold moisture depends. Those with coarse particles tend to lose moisture easily and quickly, to be warm and dry in consequence, and as we might already suspect from what precedes, to be mainly those soils upon which the Oak-Hickory are found, for while these forests types are largely a vegetative response to climate they also react very sensitively to soil conditions. In fact, if the latter are too unfavorable we often find them upsetting the response to climate by so dictating an imperative response to soil as to alter completely the expected vegetative response to temperature and rainfall. Exactly this is happening in the park today, as will be explained presently.

Upon the basis of their capacity to hold moisture the soils in the park are divided quite readily. From samples collected in different parts of the park under the two major forest types the following tabulation is based. The moisture holding capacity of each and their averages are determined by taking a small cylinder of soil, from which coarse material, rock fragments and other inert matter have been removed, getting the sample absolutely oven dry and then determining by weight its ability to absorb water by capillarity. Because the position of these sites and their elevations are of importance they are included in the table.

Moisture Holding Capacity of Mineral Soils
In Allegany State Park
(*In per cent of dry weight*)

BEECH-BIRCH-MAPLE			OAK-HICKORY		
M. H. C.	Location	Elevation in feet	M. H. C.	Location	Elevation in feet
54.4	Lookout trail	2200	50.8	Holt's run	1700
65.9	Cain's run	1500	56.4	Elko	1650
56.8	Big Basin	2000	48.1	Peter's creek	1525
68.0	Headwaters, Red House brook	1975	57.4	Holt's run	1700
51.4	McIntosh creek	1680	41.8	Salamanca road	2075
			48.8	Bradford-Salamanca road	1475
			31.9	Limestone run	1570
59.3	Average		48.1	Average	

While there is naturally great variation in the figures given under each type, and subsequent studies carried on more extensively than was possible in a single season may change the results, it is nevertheless clear enough that the average moisture holding capacity under the Oak-Hickory is lower by over 10 per cent than that of the Beech-Birch-Maple type. Soils of a lower M. H. C. (moisture holding capacity) are apt to be less fertile, drier and warmer, all of which corresponds with the requirements of the two forest types and with their geographical range outside the park. Such a purely mechanical analysis of soil particles tells us nothing of the inherent fertility of such soils but it is a good measure of their mechanical constitutents and helps to explain the main distribution trends in the park. One must view these as dictated partly by climate, as we have seen, partly by soil preferences, as the table appears to indicate, and partly by competition between the different trees for light.

Sometimes one and again another of these major factors of change will outweigh the rest. In two instances not included in the table, the soil seems to dictate absolutely what has happened. These two cases are the occurrence of the Scrub Oak, *Quercus prinoides*, at Old Town School, just across the Allegheny river from Elko mountain, and the other is the equally extraordinary occurrence of the Balsam Fir in the Red House valley.

Both these vegetative types are rather far afield. The one belongs far to the North, where Balsam forests make huge coniferous woods on vast stretches of northeastern America. The Scrub Oak is mostly at home in any considerable quantity along the warm coastal plain from Long Island southward. The Fir occurs south of Allegany, but at much higher elevations and the Scrub Oak north and east of the park, but at lower elevations and naturally on locally warmer sites.

Both the Fir and Scrub Oak seem certainly to occur at Allegany State Park because of soil conditions. A glance at the table below will give the story in a nutshell.

Moisture holding capacity of Balsam Fir and Scub Oak soils compared with the average of those under Beech-Birch-Maple and the Oak-Hickory forests

Average of Beech-Birch-Maple	59.3%
Average of Oak-Hickory	48.1%
Scrub Oak, *Quercus prinoides*	28.5%
Balsam Fir, *Abies balsamea*	196.9%

The last two per cents are so much below and above those for the rest of the park that the occurrence of the two very different vegetative types may well be explained upon these soil factors. More will be said regarding the Fir presently, as it is within the park area, while the Scrub Oak is just across the river but outside the park.

All these mineral soils are overlaid by humus of varying degrees of depths and richness, and this blanket of vegetable matter tends to stabilize soil temperatures, but in spite of this humus cover the temperature of the soil appears to differ slightly under the different major forest types, and markedly so under the Scrub Oak station at Old Town School. A series of temperature readings made at 18 inches below the surface shows the following:

Average soil temperatures under different forest types at Allegany State Park, taken at intervals from July 19 to August 22, 1927

Beech-Birch-Maple	50° F.
Oak-Hickory	54°
Scrub Oak, *Quercus prinoides*	65°
Balsam Fir	56°

Soil temperatures do not vary much and plants appear to be rather sensitive to changes in it, so that it is perhaps not surprising to find only 4° difference in the temperatures under the two major forest types, and the considerably higher temperature under the Scrub Oak is perfectly in agreement with the sandy soil of low M. H. C.

and the well-known soil preference of this species in its normal home along the coastal plain.

Another feature of the mineral soils is the amount of acidity in them. All soils in the park are somewhat acid, as scores of tests show very clearly. Plants are often extremely sensitive to changes in acidity, particularly when there are changes in the fundamental mineral soil.

Within the past few years there has been an immense amount of work done on this question of the acidity and alkalinity of soils and of the effect of this upon plant growth, particularly as this affects wild gardens.

To understand what follows it is necessary to explain the nature of acidity to alkalinity and of the method of determining it. Dr W. A. Taylor has written a non-technical account and a technical one of the details of this problem, and from these two the following is largely drawn.

All liquids of which water makes up a part contain free H and O H ions. If the solution is neither acid nor alkaline, in other words, precisely neutral, the number of H ions exactly equals the number of O H ions. If, as in the park soils, there is indication of acidity, then the number of H ions exceeds the number of O H ions. If, as in the salt marshes along the coast or the alkali regions of the Far West, there is a definitely alkaline condition, then there is an excess of O H ions over H ions. While this explanation appears simple enough the actual *cause* of the acidity is the number of H ions in a solution. In other words, acidity may be measured by finding out what that number is—the determination of the hydrogen ion concentration as it is called.

There are several ways of doing this, at least two of them requiring either elaborate chemical technic or the possession of a potentiometer which determines the hydrogen ion concentration electrically. For the average person both these methods are too involved. There has recently been devised a method of hydrogen ion determination that is much simpler and can be accomplished by anyone willing to follow accurately the simple directions necessary.

The old litmus paper method for determining whether a soil was acid or alkaline depends upon the fact that its coloring substance changes color when exposed to an acid or alkaline solution. Recently it has been found that certain chemical substances, called for this purpose "indicators," react to different degrees of hydrogen ion concentration by changing color. Elaborate schemes are now available which give the color range for all the indicators that one would ever use in soil work, from the most acid to the most alkaline, a set of 12 indicators in all.

For most practical soil purposes in the eastern part of the United States these are all that are necessary, because with them can be measured all ranges of hydrogen ion concentration from 4.0 to 8.8. Exactly what these figures mean would involve too lengthy a chemical discussion to include here, but their practical meaning for purposes of hydrogen ion determination is just as valid as the scale on a thermometer where a degree Fahrenheit means technically a lot more than it does for the non-technical reader who merely knows the scale of the thermometer as a measure of heat and cold.

A scale of hydrogen ion concentration or, as the experts call it, the p H value, has been worked out, and using that scale as a practical matter does not necessarily involve a knowledge of all that has been written about hydrogen ions and the number of them. What the p H scale does, as a practical matter, is to give us a reasonably accurate measure of the degree of acidity or alkalinity, depending upon the color reactions of the indicators when mixed with the soil solutions.

Several soil indicator sets are now on the market, all of them working on the principle that the indicators change color when mixed with soil solutions and change in measurable and rather accurately determined ways. Since all these sets furnish directions for using them, these need not be repeated here. The scale to which all are fitted is the following:

The p H or Hydrogen ion scale

4.0		Extremely acid
	4.2	
	4.4	
	4.6	
	4.8	
5.0		
	5.2	
	5.4	
	5.6	
	5.8	
6.0		
	6.2	
	6.4	
	6.6	
	6.8	
7.0		Neutral: neither acid or alkaline
	7.2	
	7.4	
	7.6	
	7.8	
8.0		Alkaline

p H of Allegany State Park

Mineral soils

BEECH-BIRCH-MAPLE	OAK-HICKORY
6.2	6.1
6.1	6.0
6.0	6.0
6.2	6.0
6.4	6.2
6.2	6.0
6.4	5.8
6.2 Average	6.0 Average

While the differences here seem too slight to be significant, there is most likely hidden within this whole question of p H value of the underlying mineral soil much important information. Time and laboratory tests alone can reveal these factors, neither of which was available during a brief summer study of the park vegetation.

So far as surface humus is concerned, it varies much more than the mineral soil beneath it, for it can be destroyed by fire and burned up by the sun. This is why under the comparatively open canopy of the Oak-Hickory the humus is apt to be poor and thin, while under the closed dense canopy of the Beech-Birch-Maple it is usually deeper and richer. In terms of specific acidity, the humus in the park varies much more than do the mineral soils. The following table gives the averages of many tests on humus from different vegetation types and shows rather conclusively the preferences of certain of them for rather definite degrees of acidity.

p H of Allegany State Park humus soils

Beech-Birch-Maple ..... Average of 8 samples	6.7
Oak-Hickory .... Average of 6 samples	6.2
Balsam Fir, Red House..	6.2
Scrub Oak, *Quercus prinoides*	6.0
Recently burned area....	5.8
Fallen Hemlock log in Big Basin :..........	4.6

These varying degrees of acidity have profound effects upon the distribution of the herbs growing in the humus. One of the most striking features of this is the last item. Here on this old Hemlock log, from which the bark was stripped many years ago, is found the lowest p H value, or the highest acidity of anything found in the park. Of itself this would mean little except for the fact that the Hemlock logs are carrying out the destiny of the vegetation of which they were once a part, by serving as a site upon which hundreds of tree seedlings get their first start. We know too little about the germinating capacity of forest tree seeds. Certainly for hundreds of millions that fall annually only a handful ever sprout, much fewer grow to saplings and in many acres of the park it is common to see no tree reproduction. On nearly every Hemlock log, however, whether fairly sound or completely rotted, there is nearly always a luxuriant growth of tree seedlings and of herbaceous plants that may be wholly lacking on the forest floor upon which the log has fallen.

One such log in a mature forest of Beech-Birch-Maple was particularly striking, although it is merely an illustration of what is going on all over the park. The particular one here described had an acidity much higher than the surrounding surface humus, and in the moss, which was scarcely three quarters of an inch thick, the following plants were counted. The log was about 25 feet long and 2½ feet in diameter. All these grew, of course, only on the upper side of the log. The plants on it were:

Hemlock seedlings	38
Yellow Birch seedlings	30
Oxalis acetosella	10 patches, not plants
Acer pennsylvanicum	3
Lycopodium lucidulum	6
Various young ferns	17
Sambucus racemosa	3
Unifolium canadense	2

While the beauty of these old moss-covered logs, fringed by these ferns and flowering herbs, is their most striking characteristic, their really significant contribution to forest economy is the fact that even in death they are providing a highly specialized site for the reproduction of tree seedlings, their own and those of Yellow Birch. Without experimental evidence to the contrary it appears that the highly acid nature of these old Hemlock logs is the chief cause of the freedom of germination of the tree seedlings found on them. This is even more striking when, as often happens, one finds such moss and plant-fringed logs in a bare carpet of dead leaves. Perhaps the final touch of the contribution of the Hemlock is to find old standing stumps of it crowned by young thrifty Birch trees (see figure 19). Several such have been seen. The old Hemlock stump is usually three to four feet in diameter and about as high, with only a shell left, as the interior wood is mere punk. But in this and supported by it until the birch seedling can support itself, grows this final answer as to what part Hemlock plays in

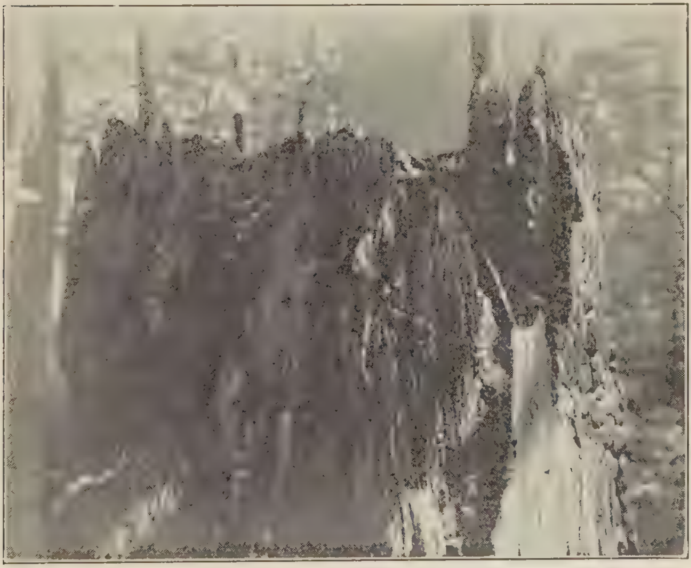


Figure 19 A giant Hemlock stump with a thrifty Yellow Birch sapling growing in it (near right-hand edge of the stump). See pages 10 and 88 for details of this and other final contributions of the Hemlock to the perpetuation of the climax forest.

the maintenance of the climax forest of which it is a part. There can be no more striking example of the effectiveness of the response of plants to a purely local, absolutely accidental production of a specialized soil condition, for it seems unescapable that the high acidity of these stumps and logs of the Hemlock are the cause of this common and picturesque feature of the park forests.

The other and more widely operating soil factor is involved in the occurrence of the Balsam Fir at Red House.

BALSAM FIR FOREST AT RED HOUSE VALLEY

A clear and accurate description of this interesting site has already been given by House and Alexander ('27, p. 177), so that it is needless to repeat a list of species in it. Whether the area was ever once a true Balsam swamp or not it certainly is not now and there is little indication that it ever will be (figure 20).

Considering that it is a flat warm site (the hill north of it is covered with Oak-Hickory forest) the truly extraordinary feature of the place is that the Balsam has persistedat all. Today it seems as though it was putting up a losing fight, as few of the trees are vigorous and none of them of any size. Most are less than 20 feet high.

Per cents of the different trees. As a record of their present proportion to the trees among which they grow, the following per cents of trees of all sorts seem worth recording.

Per cent of different trees in the Balsam swamp

Hemlock	33.3%
Balsam Fir	22.5
Yellow Birch	16.6
Red Maple	5.0
White Pine	16.6
Black Ash	4.1
Quaking Aspen	1.7
Total	99.8

This shows how far from a true Balsam forest type the local representative is. In the Adirondacks or at lower elevations farther north the Fir would be at least 85 per cent of all trees, often as high as 95 per cent. With a frequency per cent of only 22.5 at Allegany it is an interesting relic rather than a significant forest type, and as pointed out in the section on soils, its occurrence here, even in this somewhat decrepit condition, is response to a soil condition observed nowhere else in the park. A moisture-holding capacity of 196.9 per cent is almost four times greater than anything else found in the park, and it seems difficult to escape the conclusion that it is this fact that dictates the occurrence of the Fir here. Although it is climatically out of its range and yet occurs in spite of this by virtue of the influence of a soil factor which differs from all others in the park, there could scarcely be a better illustration of the pull of two different sets of factors and the results of that tension. After all, the Fir

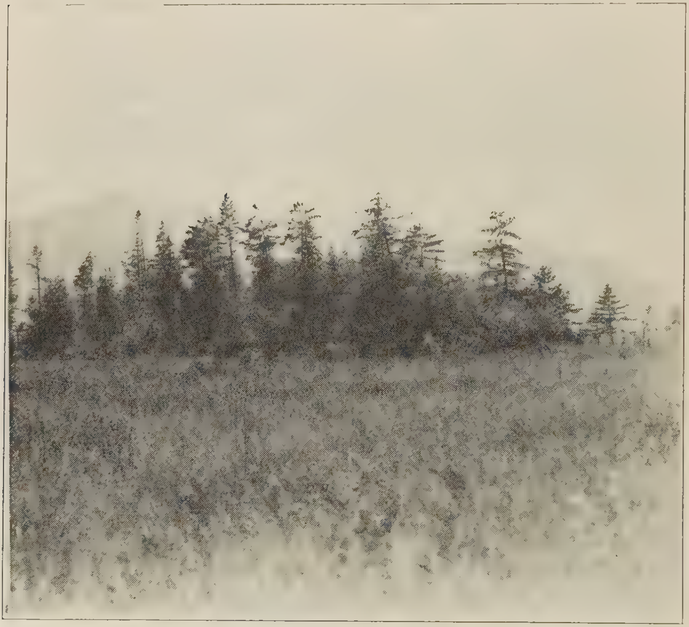


Figure 20 Balsam Fir at Red House valley. See page 91 for the details of this waning outpost of a type of vegetation that is beyond its normal range in the Allegany State Park.

is there at Red House, wretched and miserable as the trees are. By all climatic counts it ought to be long ago exterminated, but it has persisted for no one knows how long, perhaps since glacial periods. This has been accomplished evidently by its capturing a peculiar soil environment, where perhaps at first it dominated the situation. Certainly it was more extensive once than it now is, but climate will probably have its way in the end, for the number of other trees in this relic of a Balsam swamp already points the way to its final extinction, since of all our forest trees, Balsam is least able to stand competition,

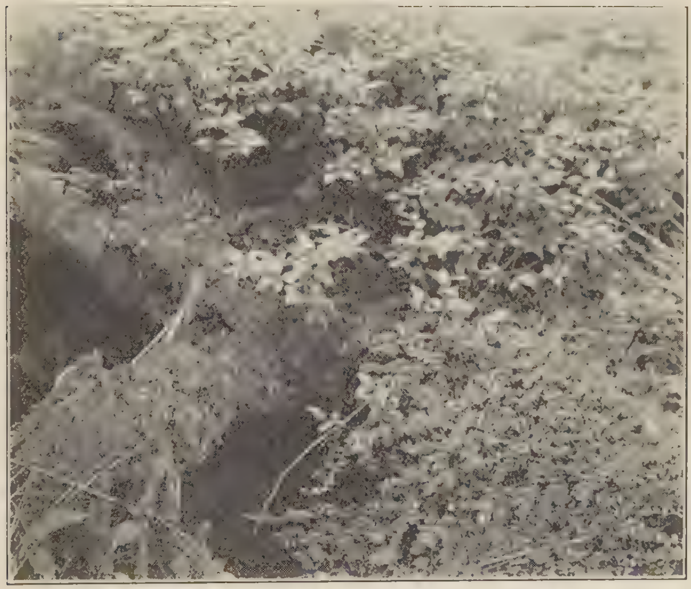


Figure 21 The small-leaved creeping plant in lower righthand corner is the Creeping Snowberry, *Chiogenes hispidula,* behind it the Sour-top Blueberry, *Vaccinium canadense,* both growing on hummocks in the balsam swamp, and both unknown elsewhere in the park. See page 94 for their probable fate.

particularly shade. Standing out in the open it might survive for centuries, but once let a sufficient growth of Hemlock and Yellow Birch get up over it and the Fir is on the way to rapid destruction. Exactly that is happening at Red House today.

An interesting feature of the Fir at Red House is that while its forest floor is, one might almost say, debauched by a horde of meadow weeds that have come in from the surrounding area, one or two survivors of the Fir's proper and usual associates still persist. These are the Creeping Snowberry, *Chiogenes hispidula* (figure 21), and the Bunch Berry, *Cornus canadensis*. The former is found nowhere else in the park, while the latter is rare elsewhere at Allegany. Both persist together with a few other plants, such as the Sour-top Blueberry, *Vaccinium canadense* (figure 21), to keep company with the Fir until the end, for it seems certain that there must some day be an end to this anomalous and unusual occurrence of the Fir. All signs point to extinction, and with it will go almost surely these few low plants that have persisted so long with it.

SUMMARY OF MAIN ECOLOGICAL FEATURES OF THE FORESTS

In closing this account of the forests in the park, it is well to recapitulate the main features of them, for in the mass of the details one is apt to forget the main trends. These are, basically, simple and direct. Their ramifications and the constant interruption of them furnish ecologists with many interesting problems and they make the casual visitor wonder what it is all about. As this little book is emphatically for the general visitor to the park and not for the professional botanist or ecologist it is perhaps as well to epitomize the preceding pages.

The forests of Allegany State Park are of two major types. One, and much the more abundant and covering most of the park, is the Beech-Birch-Maple hardwood forest, so called because of the dominance of the Beech, Sugar Maple and Yellow Birch. The other is the Oak-Hickory forest characterized by several species of Oaks, the Chestnut, some Hickories and several other species of trees.

The Beech-Birch-Maple is predominantly northern in its affinities and in the associated shrubs and herbs that usually grow under it. All of these and the trees themselves are peculiarly tolerant of the dense shade which their mature canopy always casts. The density of this shade, their own tolerance of it and the relatively much reduced tolerance of it by other trees tend to keep the Beech-Birch-Maple a close corporation. Its ability to keep out intruders and to perpetuate itself is noteworthy.

The Oak-Hickory, on the other hand, is with its associated shrubs and herbs mostly of southern affinities, so that it is mostly confined to the lower, warmer and drier sites in the park. As these are limited the distribution of the Oak-Hickory is also restricted, so that it occupies probably less than one-tenth of the area of its chief competitor, the Beech-Birch-Maple.

Both these forest types are well recognized examples of what are known as climatic climax forests, which are forest types of rather definite composition, due to climatic causes, and have the further and indispensable character of being self-perpetuating on a given site. If the park had never had a fire or been subject to the rapacity of lumbering operations the problem would end there, but as fire and cutting have both taken a fearful toll, the disturbance of natural self-perpetuation has been marked and has tremendously increased the difficulty of tracing the vegetative history of the park.

After a clean cutting and the sequel of a fire there is a long period when only weedy and temporary trees occupy land once covered by the climax forests and destined to be covered by them again. In the meantime the two species of Aspen and Pin Cherry carry on an important work of rehabilitation, the fruits of which they will never harvest. Their pioneer work means their own destruction, for all are light-demanding and all must succumb when the climax forest once gets the upper hand again.

This process may be seen in operation over hundreds of acres of park land, although with the reduction of the fire hazard and the stopping of wholesale cutting it will be much reduced in the years to come. All the apparently incredibly slow process of forest rehabilitation will be much hastened by the elimination of this long pioneer stage, and proper cutting or no cutting at all will allow normal perpetuation of the type to go on.

Perhaps all the details of this struggle for mastery between the types, the interruption caused by fire, the response to soil and the rest may not interest the casual visitor. But no one can really enjoy and understand the park unless he knows that these things are happening all around him. If he can recognize the types, appreciate at least the changes that are going on, without stopping to delve into all the details, this little account of the forests will not have been written in vain and forests will no more be merely confusing places full of "just trees."

VEGETATION OTHER THAN FORESTS

So much of the park is covered with what appears to be and very nearly is trackless forest that the casual visitor is apt to think there is no vegetation except these dense woods. While this is not exactly true it is almost so. Forests do cover the great bulk of the 65,000 acres, and except for farms, of which there are very few, and for camp sites, dense woods appear to prevail here as they did overwhelmingly over colonial America.

Even in the days of the Indians, however, there were always openings in the forest, some of them of considerable extent and a few of them occupying vast areas, such as the prairies. Even in the general forest region of northeastern America there were often considerable regions that for one reason or another did not maintain forests.

The chief nonforested areas were ponds and lakes, in which and along the edges of which a very different vegetation held sway. Another rather highly specialized area usually without a forest was bog land, of which there are still thousands of acres in northeastern America. Perhaps the most extraordinary thing about the park is that there is not a natural lake or pond in the whole area, and no bog of any kind. The physiographic and geological reason for this lack of ponds, lakes and bogs is described in detail in Doctor Lobeck's report upon that feature of the park and need not be repeated here. What it means in terms of the failure of certain plants to be found in the area is another matter.

Scores of species are normally confined to pond edges, to deeper water in them or to the sphagnum moss of true bogs. Some of these, which are wholly lacking from the park area proper, are:

Leatherleaf, *Chamaedaphne calyculata*
Swamp Loosestrife, *Decodon verticillatus*
Sundew, *Drosera rotundifolia*
Pitcher Plant, *Sarracenia purpurea*
Bartonia, *Bartonia virginica*
Buckbean, *Menyanthes trifoliata*
Cotton Grass, *Eriophorum virginicum*
Rose Pogonia, *Pogonia ophioglossoides*
Water Shield, *Brasenia Schreberi*
Water Lily, *Castalia odorata*
Rhododendron, *Rhododendron maximum*
Black Blueberry, *Vaccinium atrococcum*

Besides this very significant list of plants unknown in the park area, there are, of course, many grasses and sedges, and more important still, at least two trees. These are the Larch, *Larix laricina*, and the Black Spruce, *Picea mariana*.

Vegetation at the School Pond

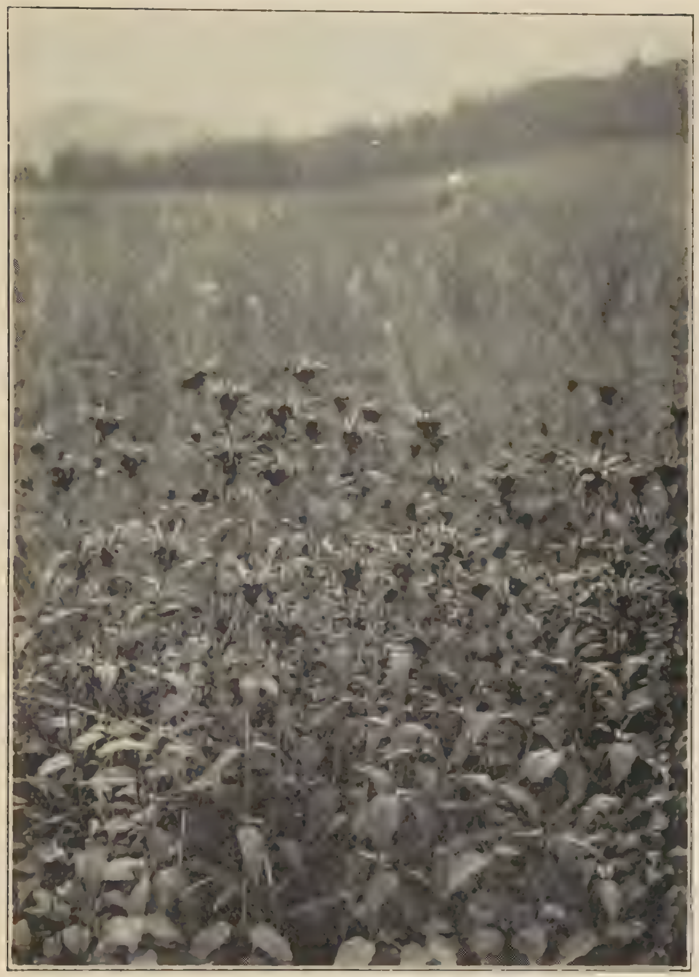
Since so many really significant species of plants growing in open places are wholly lacking in the park, it might be wondered what there is of interest about the vegetation outside the forests and their associated shrubs and herbs. One of the places of particular interest will be the artificial lake at the Allegany School of Natural History. A careful census of this area and its upper end, together with a plan of the vegetation existing in the summer of 1927, has been completed. It is too early to publish this now but it is perhaps worth recording that not one species of aquatic plant grew there during 1927, no bog plant, none of the species listed above. In fact, while the filling up of the lake has made many boglike habitats at the upper end of it, no bog species of plant or any aquatic had come into the area. Surrounded as this pond is by a dense forest, the nearest true bog or pond being many miles away, the possible establishment of bog or aquatic plants here will be of special interest. All that the upper end of the pond really consisted of during 1927, was a mass of drowned streamside or terrestrial plants that had been either practically or wholly submerged by the lake as it filled up in the spring of 1927. Of interest as possible carriers of aquatic or bog seeds was the visit of two aquatic birds during the summer, both new to the park, and both undoubtedly attracted by the creation of an entirely new environment within the park.

Stream Side Vegetation

Besides the artificial lake there are many stream sides and often they widen out a little where dense thickets will be found, of willows, alders and, on somewhat higher ground, young elm trees. It is along stream sides, too, that perhaps the showiest plant in the park grows in countless thousands. This is the Bee Balm, *Monarda didyma* (figure 22), which gives a quite gorgeous scarlet color to almost every stream side in the area. While it appears to prefer half-shaded banks it also grows quite out in the open.

Over these dense thickets of swamp and stream side vegetation there are two particularly showy herbaceous vines, the Virgins—Bower, *Clematis virginiana,* and the Balsam Apple, *Echinocystis lobata.* Usually they form long streamers or dense mats that cover large masses of these shrubs.

Much the largest and most important stream is of course the Allegheny river, which circles three sides of the park. It is, however, almost wholly lacking in true aquatic vegetation, probably because of the nature of its rocky bottom and also because of its swift flow in freshet



Photograph by M. G. Schneckenburger

Figure 22 Bee Balm, *Monarda didyma.* Often called Oswego Tea and one of the most beautiful wild flowers in the park. It grows by thousands along Quaker Run, and along nearly every water course in the area.

times. Figure 22 shows this, and for miles one can look in vain for true aquatic plants along the main stream side of the river (figure 23).

Pond Vegetation

Quite other conditions are to be found where the bottom is not rocky and the water does not flow so swiftly. None of the streams in the upper parts of the park is in such condition and consequently no aquatic plants are found in them, but some of the streams that broaden out into flat valleys near their entrance to the Allegheny river have muddy bottoms, and in such places there is the beginning of aquatic vegetation, such as is common along the edges of so many ponds outside the park. Perhaps the best example of this, and certainly the sharpest contrast between the condition of being free from aquatics in the main channel while supporting them in the smaller stream, is at the junction of Tunungwant creek and the Allegheny river, just above South Carrollton. As figure 23 shows, the main stream is wholly without aquatic plants, while at the outlet to Tunungwant creek there is a dense mass of a Pond Weed, *Potamogeton epihydrus* (figure 24). This is a true pioneer among aquatic plants here. Just as in the case of the Aspens and Pin Cherry in the succession of the forest from a poor to a richer environment, the Pond Weed bridges a tremendous gap in an aquatic environment impossible to sustain plant life, on the one hand (in the river), and beginning to do so, on the other (in the smaller stream). There are many later stages of aquatic plant life in this Tunungwant stream, stages long past the pioneer efforts of *Potamogeton epihydrus* to make ready a more favorable environment for aquatics making greater demands than it does.

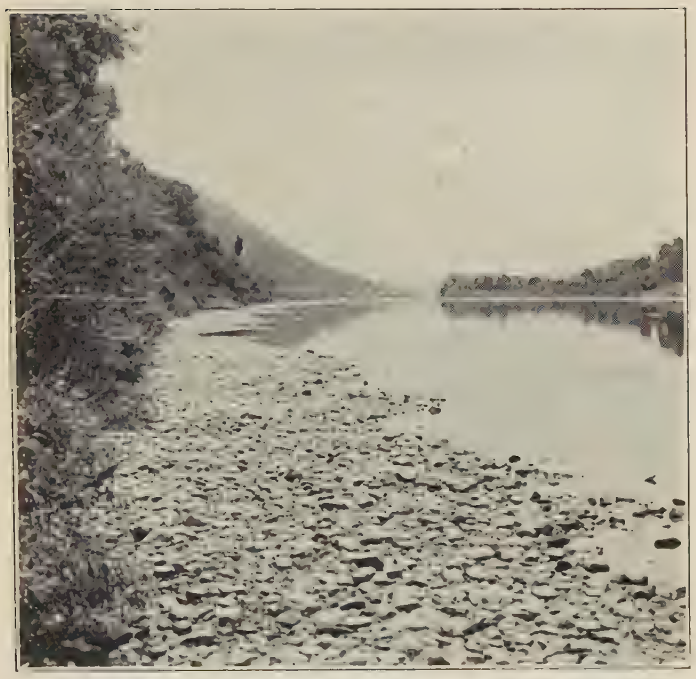


Figure 23 Edge of the Allegheny river opposite Cold Spring. Note the shingle beach and the complete lack of aquatic plants.

In spite of many stages of development that it is needless to point out here step by step, there has not yet been produced an environment within the park area capable of sustaining the beautiful fragrant Water Lily shown in figure 25. That plant is not found nearer than Randolph, and by so much is the aquatic environment still in its younger formative state in the park. It takes many ages of preparation to produce certain kinds of aquatic environment just as it does a forest one. In this respect the forests are far ahead in the effort to reach a climax condition than are any of the aquatic sites of the park.

In the long run, of course, all aquatic sites, except the swiftest streams, are always headed in the direction of ceasing ultimately to be aquatic environments at all, for in the end they fill up, become choked with vegetation

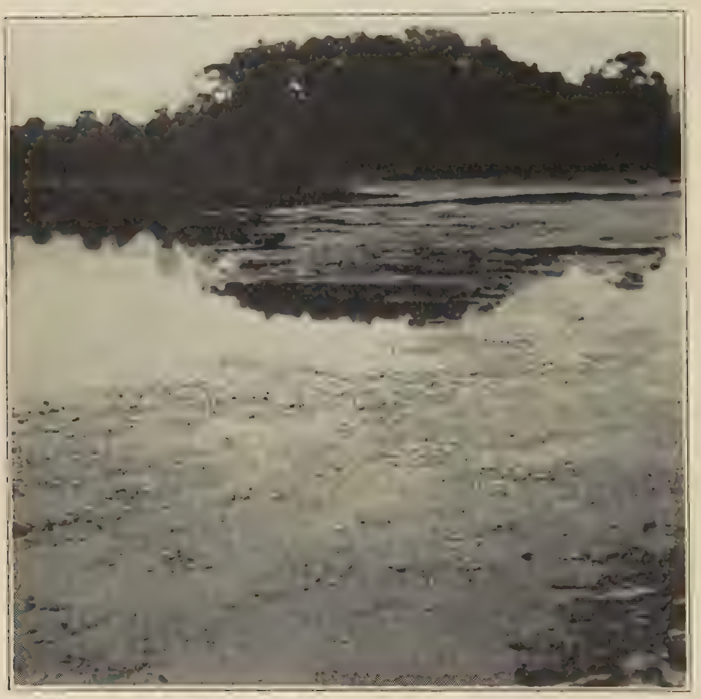


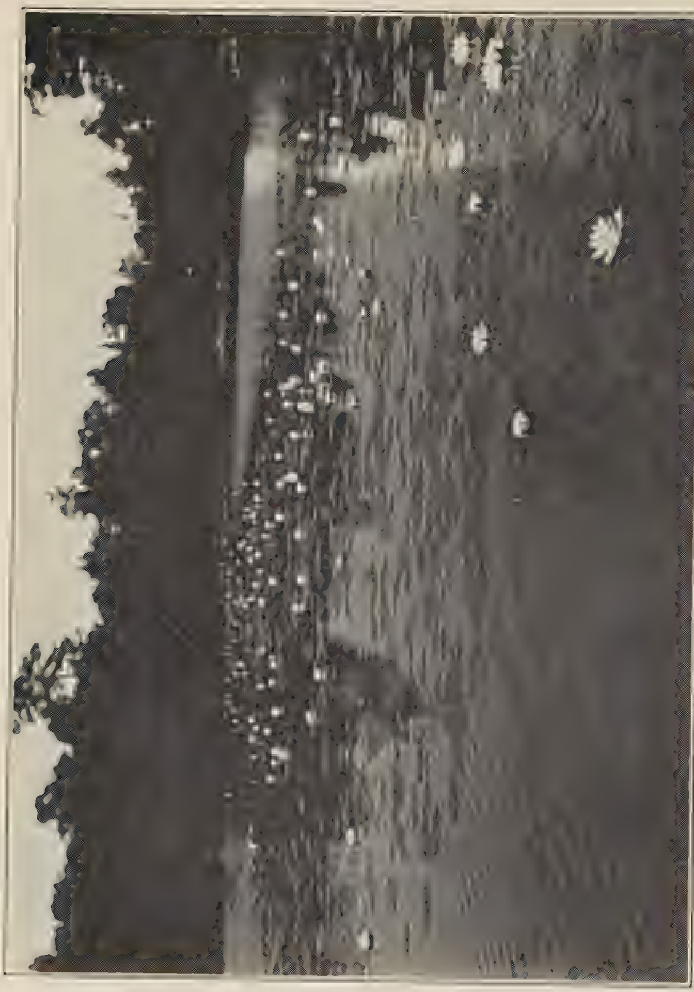
Figure 24 Junction of Tunungwant creek and Allegheny river. In the foreground are dense masses of Pondweed, *Potamogeton epihydrus.* This is the pioneer aquatic plant at the point and should be regarded merely as the first stage of a succession of aquatic plants that will end by producing habitats like that in figure 25.

which catches silt and fine detrital matter, and we have the beginnings of soil of a sort. Such soils become occupied by water-loving shrubs and trees. Long before this the aquatic plants have passed away, for they have by their mere existence begun the apparently incredible task of creating conditions in which they themselves can not grow but where their successors can gain a foothold.

The great interest of a place like the mouth of Tunungwant creek is that here within a stone's throw we can see all stages from open swiftly moving water in the larger stream to the dense swamp vegetation of Red Maple, Alders, Willows and the Plane Tree. From one extreme to the other the whole panorama of the development or succession of vegetation is shown. The earliest pioneer is the Pond Weed, and the Water Lily is wholly lacking in this particular site, but in countless other such places it survives for perhaps hundreds of years, when it too gives way to its successors.

There are other open places in the park besides these aquatic environments. Such are those shown in figures 16 and 17. It does not matter what the cause of the opening may be, whether the substratum is moving water, rich humus, bare mineral soil or recently scorched land. Wherever such places occur we see going on before our eyes a process that always heads in one direction—the utmost development of the vegetation that the site can ultimately produce. Vegetation as a ceaseless moving body, ever moving toward a perfection, often temporarily or for centuries unattainable—that is a picture of plant life, the study of which far outweighs the finding of a handful of rare plants, be they ever so beautiful.

Disentangling the factors of control in such a process seems an almost hopeless task. Actually there is a tre-



Photograph by M. G. Schneckenburger

Figure 25 Water Lily, *Castalia odorata.* One of the stages in the development of acquatic vegetation that is missing in the Park. The nearest occurrence of it is in "a marshy pond on Pine Hill, near Randolph."

mendous mass of information already accumulated along this line. In the park climate, soil, site, fire, elevation, geographical origin and what not, are all pulling one way or the other in the attempt to control the destiny of a particular piece of vegetation. Perhaps the main lines of this struggle have been made a little clearer by this handbook. Perhaps some visitors will see in the park vegetation an unending panorama of change—always to some perfect state not yet attained except at a few points in the area. If so and if they are moved to take up even one of the many problems which remain to be solved, then this account of the gross features of the ecology of the plant life will not have been written in vain.

AS SEEN FROM A MOTOR

Without making special effort the casual motorist may see many plant societies without getting out of the car. Of course such a view is a superficial one, but the number of persons who merely drive through the park without stopping for more extensive observation makes it desirable to state what may be seen in this way before outlining definite excursions for special objectives.

In almost no place in the park does a main motor road travel through the virgin, untouched timber, and it is perhaps best that this is true, for the fire risks of constant traffic would be too serious to outweigh the advantages of easy access.

But there are miles of good second-growth forest immediately skirting the roads, and some of these are worth noting:

Route 1 Road from Bradford-Salamanca Triangle to Quaker Bridge Village

For nearly 10 miles this passes between sturdy, vigorous young forests of Beech-Birch-Maple; or else, at the lowest and highest elevation of Oak-Hickory forest. See p. 62 of this handbook for an account of the climatic inversion illustrated on this drive.

Route 2 Road from Salamanca to Red House Valley, via the "Scenic Highway"

As one passes beyond the limits of the town there is an instructive illustration of the Oak-Hickory forest gaining a temporary, or it may be a somewhat long-continued occupancy of a region that will probably reach the climax stage of the Beech-Birch-Maple now that the land is in the park and cutting and fire are reduced or eliminated. Until you reach the fire tower on top of the hill the forest is all of the type noted on p. 37–54, but as you go down the road towards the Red House valley, the Oak-Hickory gives way to Beech-Birch-Maple.

Route 3 Road from the Indian Schoolhouse to Elko, along the East Bank of the Allegheny River

The forest here is a rather young but very vigorous growth of the Oak-Hickory coming up in a region that has been much cut and subjected to repeated fires. Note the enormous number of coppice trees to the acre. Such a crowded stand can of course never reach maturity, and in its later stages there will be ruthless pruning out of these tolerant species that, while they can stand the shade, will not thrive well in a region as warm and sunstruck as this is.

Along all roadsides, except where they pass cultivated fields, the edge of the road rarely supports the forest trees of the immediate region, which may be in perfect development 50 feet from the road. Road building, grading and the annual cutting of "brush" by the highway maintenance force, all tend to destroy the vegetation, as they certainly destroy the esthetic value of the road as a site for natural development of vegetation. All this results in a strip of weedy or shrubby vegetation along the roadside that often well illustrates the problems of the changing phases of the vegetation mentioned on p. 69.

PLANT SOCIETIES AND THEIR LOCATION FOR FIELD EXCURSIONS

So many admirable excursions have already been outlined in the handbooks on geology and on the flora of the Allegany State Park region that it may seem unnecessary to suggest still others. It would be quite so if our objects were the same; but they are not. The few suggestions offered below are chosen not with a view of finding any particular plant or wild flower, however showy. Such suggestions have been very completely covered by House and Alexander.

The suggested trips below are all planned with a view of illustrating some of the features of the vegetation of the park outlined in the preceding pages. They are not so much voyages of discovery as opportunities for perhaps more extended observations and study than most visitors can give them, but they at least make definite objectives for half-day or all-day trips, and some of the places at least would take months to really understand all that is happening in them.

Excursion 1

Mature Climax Forest of Beech-Birch-Maple, Big Basin

Here one can see the only piece of practically virgin forest in the park. The trees are wide apart, indicating good age of the stand, and the thinning out by suppression of thousands of trees that their giant survivors may arch their tall crowns over the closed canopy. See page 14 for the details of this forest and its associated vegetation.

This is best reached by going due north from the height of land on Bay State road (elevation 2216 feet) to the headwaters of Stoddard brook. The easiest way to find the best development of this forest is to watch your direction, which should be due north, and if you miss the direction for lack of a compass or sun, keep on going down hill; not, of course, paralleling the Bay State road but at approximately right angles to it. There are no helpful trails, and a compass or good woods sense of direction are essential to an easy, and, on cloudy days, a safe return.

In going by car from the Allegany School of Natural History, drive easterly to the triangle made by the Salamanca-Bradford roads, turn left at this point and follow in a northerly direction until the Bay State road is reached. Distances are school to triangle 2.6 miles; triangle to Bay State road 3.2 miles.

Turn west on Bay State road and follow its meanderings for about 2.5 or 3 miles, until you come to the highest point on the road, which is perfectly unmistakable, and is at an elevation of 2216 feet.

Excursion 2

Nearly Mature Forest of Same Type, Headwaters of Red House Creek

This is only slightly less perfect than that in the Big Basin and of much easier access. The trees are not so big, nearer together, and the forest contains more Hemlock than at the other locality (see text, page 14).

To reach by car from the school, follow the motor directions on trip 1 until the Bradford-Salamanca triangle is reached. Park your car there and do not attempt to drive down the road you will walk down, mentioned in the next paragraph. It is an abandoned road and perfectly safe for walking but dangerous for cars. After parking cars follow nearly due north the abandoned and marked "closed" road that starts at the triangle made by the Salamanca-Bradford road (elevation 2320 feet). Follow the abandoned road down hill steadily for about one mile; then go straight west through the woods to the edge of Red House Brook, here a mere trickle. The stream is not more than a few hundred feet from the road.

There is here a wonderful growth of Ground Pine, a species of *Lycopodium,* and the longest hemlock log clothed with tree seedlings and ferns observed in the park (see page 88).

Excursion 3

Initial Recovery from Cutting and Fire, Bradford-Salamanca Road Triangle (elevation 2320 feet)

To reach this place follow motor directions given for trip 1, 2.6 miles from the school.

Here one can see the early and later stages of the recovery from cutting and fire. Over large sections only the Bracken or still more pioneer weeds have come in. Other parts of it show overwhelming predominance of the two Aspens and the Pin Cherry. Still later stages show the beginnings of the establishment of Beech-Birch-Maple seedlings (see page 75). All the vegetation in this area is a fine illustration of what disturbance will do to such a region. It duplicates on a large scale what may be seen along many miles of the park roadways.

Excursion 4

Good Type of Direct Recovery of Beech-Birch-Maple Forest after Cutting but no Fire, Near Head of Cain Run

A thrifty and typical young stand of this climax forest which is only about 20 years old. It was completely cut off except for seed trees and today its thrifty growth.

closed canopy and associated vegetation are in marked contrast to those in 3 or 5.

It is best reached by going up the road in Cain's hollow to within sight of the last house; turn into woods at right of road and go up the hill (see page 74).

Excursion 5

Large Burned Area Along Stony Brook

One of the largest burned-over areas in the park. There are hundreds of acres with no shrubs or trees and where Bracken fern now holds sway. The evidence seems to point to ultimate recovery of the Beech-Birch-Maple, but disturbance has been so drastic that a long session of Oak-Hickory forest may well precede the climax. Elevation 1900–2100 feet. Very large old stumps show the area to have been once heavily forested.

It is best reached by following Stony Brook trail about two miles in a generally northerly direction, until it crosses Stony brook for the first time, when the burned area is reached.

The lower third of this trail passes through what must once have been a splendid forest, now in process of second or third growth of healthy young trees. Scattered among these are numerous stumps of Hemlock and a few Black Birches, the latter bigger than any living trees of this species seen in the park.

Excursion 6

Nearly Mature Oak-Hickory Forest, Hill along Holt's Run and between it and Allegheny River (elevation 1700 feet)

To reach by car from the school, drive on the Quaker Bridge road towards the village and turn north to Holt's

Run road about one-half mile. Walk straight up the hill (northwestward) until the 1700-foot level is reached, which is in the middle of the best development of this forest, and a little above the temperature station for it mentioned on page 60.

This and Huckleberry Hill to the northward are typical examples of the open-canopied type of this forest (see page 37).

There are several other places all along the general valley of the Allegheny river where this may be seen, notably along the road to Elko, along Peter's Creek road, toward the village of Red House, at Carrollton, and along lower elevations of Limestone brook; all are at comparatively low elevations.

Excursion 7

Interrupted Recovery of the Forest, Due to Clean Cutting and Subsequent Over-grazing, Cain's Run

The hillside is in the angle made by the Cain Hollow road and the Quaker Run road, and within plain view from both roads (see figure 17).

Not all the failure of the Beech-Birch-Maple to come back at once is due to fire. In this large pasture cattle have killed off all the normal pioneers from the adjacent forest. The hillside is now nothing but grass and thorn bushes which are too prickly for forage. Elevation 1500–1800 feet (see page 75).

Excursion 8

Balsam Swamp, Red House Valley (elevation 1400 feet)

This is the only occurrence of this tree in the park, where it is climatically outside of its range. With it are associated several other plants that seem to have come with it from farther north (see page 91).

The small patch of Balsam Fir is in plain sight, about 1000 feet north of Red House road, and about one mile west of the McIntosh Creek road which leads to the scenic road to Salamanca (see figure 19).

Excursion 9

The Lookout Tower at Summit above the City of Salamanca (elevation 2400 feet)

This is best reached by car from Salamanca by taking the scenic road direct to the tower. From the school follow motor directions of trip 1, but instead of turning at Bay State road, keep straight on until the Red House road is reached at a sharp left turn. Follow Red House road almost due west until you reach the intersection of the McIntosh road. Turn due north (right) and follow this road until you reach the tower.

Here one gets a splendid panorama of the forests in this part of the park. Just below are young Beech-Birch-Maple woods that were cut off some years ago and are now coming back directly, either as coppice stumps or as seedling trees. Farther down the road towards Salamanca, at and near the 2075-foot level, the disturbance must have been more drastic, for here the Oak-Hickory is coming in as a temporary or perhaps rather permanent stage. All the herbaceous associates of the Oak-Hickory are well established, although the region must have been covered originally with Beech-Birch-Maple forest.

Excursion 10

Aquatic Vegetation at Mouth of Tunungwant Creek

Where this creek empties into the Allegheny river there is the best chance in the park to see pioneer aquatic plants beginning the first stage towards the climax type (see page 102).

This is best reached and can be conveniently reached only by crossing Tunungwant creek at Irvine's Mills and following north along the road that follows the creek to its junction with the Allegheny river. Along this road, as at so many places along the river, there is a fine development of young growth of Oak-Hickory forest, long since cut but now coming back vigorously.

VALUE OF THE PARK AS AN ECOLOGICAL PRESERVE

While the forests are quite obviously the main attraction at Allegany and while this little handbook has chiefly dealt with the development of them, that is not the beginning and end of ecology.

If we were able to see the first stages, of which the forests are the result, a very different picture would have to be drawn, for these early stages are infinitely slow and tedious in their development, and for long periods there would be no flowering plants at all in the first steps in the transition from bare rock or bare mineral soil to whichever one of the final climax forest types is to win. Fungi, lichens and mosses all play a tremendously important part in transforming bare rock or mineral soil into more hospitable sites for more exacting plants. The quite extraordinary effectiveness of all these lichens, fungi and mosses in the earliest stages of vegetative covering has been ignored in this report, largely because most of these organisms are difficult to identify, at least for the amateur, and also because vast stretches of the park are no longer in need of this pioneer work as the forest, meadow or stream side or whatever other vegetative picture one may find has reached a stage of development where quite other factors are dominant. It is none the less true that to go back to origins one should study these organisms, their destructive secretions, which eat away the hardest rock, and all the other methods which tend to build up a vegetatively impossible site into one that ultimately produces a climax forest.

It is of course the climax forests and the changes in them that are most obvious, even to the hurrying motorist, in many cases. To the tramper and more permanent visitor these constantly changing phases of the forest vegetation form one of the major attractions of the park. Here spread out in lavish fashion are all the panoramic changes in vegetation; here one may see the beginnings and the final stages, as in the Big Basin.

It is upon this forest that the camper depends, for it creates the conditions—true ecological conditions—of shade, temperature, moisture and the intangibles that make up the beauty and magic of the forest. All this is at Allegany for the asking and there is only one condition—preserve the forest.

On the score of preservation one or two practical things suggest themselves. Fire, of course, needs no further stressing, to those who from what has gone before perhaps realize for the first time the enormous destruction caused by it.

There are things, however, only slightly less important than fire, in helping to preserve the unspoiled handiwork of nature. Many sections of the park ought never to have motor roads through them. Motor traffic is necessary and from their cars many persons will no doubt get their only view of the forests. But there are dim and still remote forest glades where motors never should be allowed. There only man, afoot, with the walking and flying woods creatures and the giant trees should be permitted freedom from the noise and dust and odor of motors, not to speak of the serious disturbance of ecological conditions that comes with the cutting of such a road through mature timber. Besides the Big Basin there are several other parts of the park that should be forever free from traffic, where nature can work out the ecological destiny of the region.

It scarcely needs stressing that in such a plan of park development a few trails are worth a multitude of highways except where the latter serve as necessary arteries. It ought not to need stressing that wherever from road building, grading or clearing, it is necessary to replant, only shrubs and trees *native in the park* should be used. That is not true at the present moment as thousands of exotic trees have already been planted, many of them inferior in esthetic value or as timber to the native trees. The whole problem of planting, cutting for firewood and proper decorative planting around buildings needs attention if the essential wildness and freshness of the place are to be preserved.

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